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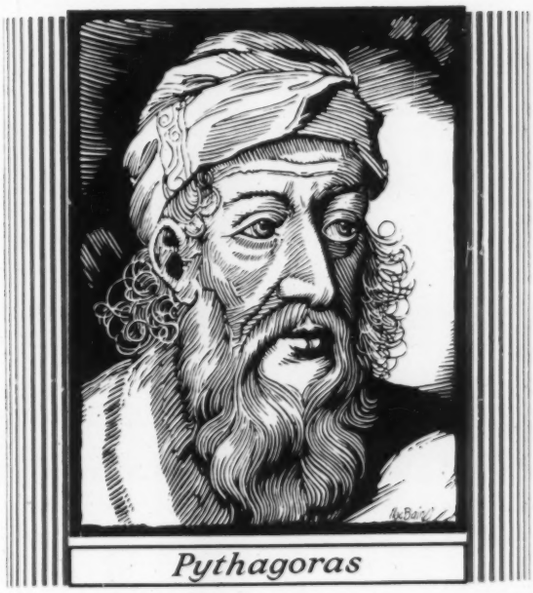
MACHINE DESIGN



Pythagoras

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES

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Itemized Index, February, 1933

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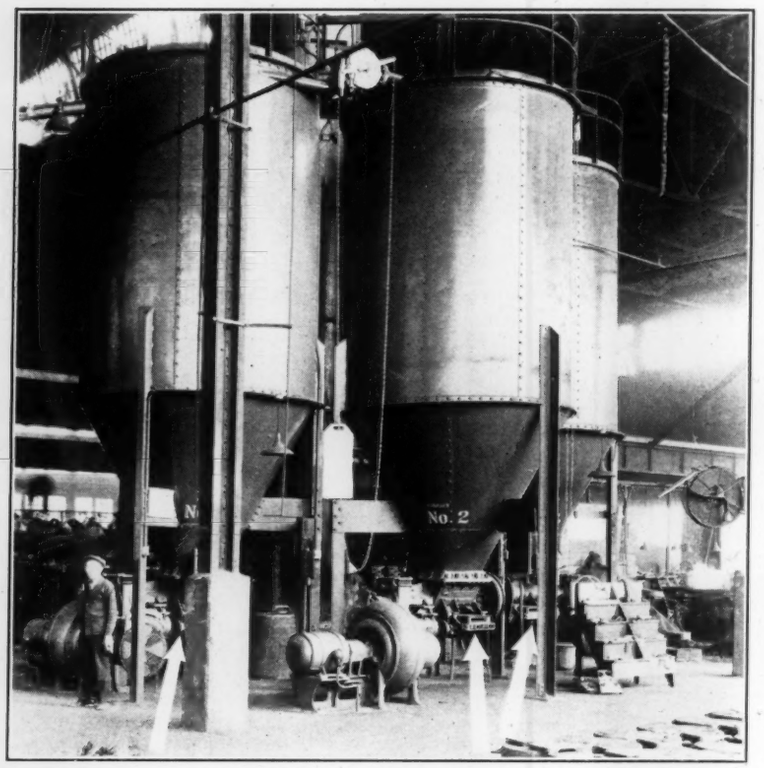

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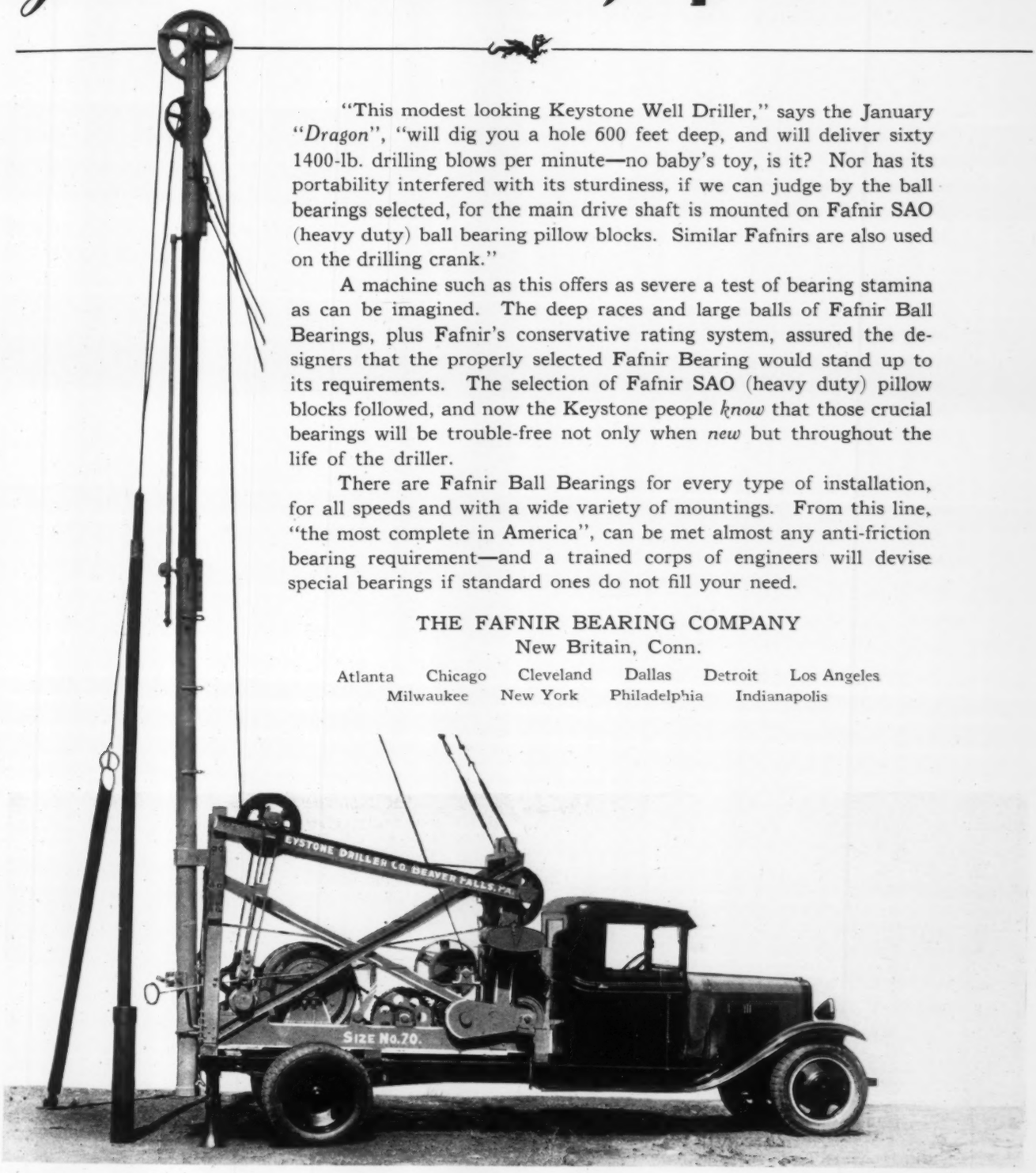

"This modest looking Keystone Well Driller," says the January "*Dragon*", "will dig you a hole 600 feet deep, and will deliver sixty 1400-lb. drilling blows per minute—no baby's toy, is it? Nor has its portability interfered with its sturdiness, if we can judge by the ball bearings selected, for the main drive shaft is mounted on Fafnir SAO (heavy duty) ball bearing pillow blocks. Similar Fafnirs are also used on the drilling crank."

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Calendar of Meetings and Expositions

Feb. 12-17—American Ceramic society. Thirty-fifth annual meeting and exhibition of equipment will include papers on "A Peculiarity of Sheet Iron Acid-Resisting Cover Coat Enamels," "New Developments in Chromium Plating," and "A Description of a Semi-Automatic Machine for Glazing Spark Plug Porcelains." Ross C. Purdy, 2525 North High street, Columbus, O., is secretary of the society.

Feb. 13-16—Technical Association of the Pulp and Paper Industry. Annual meeting to be held at Hotel Pennsylvania, New York. R. G. Macdonald, 370 Lexington avenue, New York, is secretary of the association.

Jan. 20-21—American Society of Mechanical Engineers. Technical meeting under the joint auspices of the applied mechanics division and the Los Angeles section of the society to be held at California Institute of Technology, Pasadena, Calif. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

Feb. 20-23—American Institute of Mining and Metallurgical Engineers. Annual meeting to be held at Engineering Societies building, New York. A. B. Parsons, 29 West Thirty-ninth street, New York, is secretary of the society.

Feb. 23-23—Welding Conference and Exhibition. Second annual meeting and exhibition of equipment to be held at Ohio State university, Columbus, O. O. D. Rickly, Director of Engineering Shops, Ohio State university, is in charge of the exhibits.

March 5-12—Leipzig Trade Fair. Exhibits from thirty-two countries will be included in this annual exposition to be held at Leipzig, Germany. Information may be obtained from Leipzig Trade Fair Inc., 10 East Fortieth street, New York.

March 7-10—Package Machinery Manufacturers. Meeting to be held in New York during annual packaging exposition. H. H. Leonard, Consolidated Packaging Machinery Corp., New York, is chairman of the meeting committee.

March 7-10—American Management association. Third Packaging, Packing and Shipping Congress and Clinic to be held at Hotel Pennsylvania, New York. Subjects to be discussed will include a review of recently developed packaging equipment and the tools of the packaging industry. John E. Goetz, 225 West Thirty-fourth street, New York, is managing director of the association.

March 13-16—National Railway Appliance Exhibition. To be held at Chicago. C. W. Kelly, 1014 South Michigan avenue, Chicago, is manager of the exhibition.

March 15-17—American Railway Engineering association. Annual meeting to be held in Chicago. E. H. Fritch, 59 East Van Buren street, Chicago, is secretary of the association.

March 22-24—Re-Engineering for Economical Manufacture. Conference sponsored jointly by Case School of Applied Science and Cleveland Engineering society to be held at Case School, Cleveland. Information on the meeting may be obtained from H. R. Young, Case School of Applied Science, Cleveland.

March 26-April 1—American Chemical society. Eighty-fifth meeting to be held at Washington. Dr. Charles L. Parsons, 728 Mills building, Washington, is secretary of the society.

April 13—American Management association. Job Order production division and mass production division conference to be held in Cleveland will include discussion of product design and its influence on set-up time. Kenneth B. Andersen, 20 Vesey street, New York, is secretary of the society.

April 26-28—American Welding society. Annual meeting to be held in Engineering Societies building, New York. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary of the society.

May 11-13—Electrochemical society. Spring meeting to be held at Montreal, Que., Dr. Colin G. Fink, Columbia university, New York, is secretary of the society.

May 29-30—International Association of Blue Print and Allied Industries. Annual meeting and exhibition of equipment to be held at Buffalo. R. Bloomfield, 161 Washington street, New York, is secretary of the society.

June 1—World's Fair. 1933 exposition will open on this date at Chicago. Engineers' day will be June 28. Information may be obtained from the management at Burnham park, Chicago.

June 26-36—American Society for Testing Materials. Exposition of testing equipment and annual meeting to be held at Hotel Stevens, Chicago. C. L. Warwick, 1315 Spruce street, Philadelphia, is secretary of the society.

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

February, 1933 Vol. 5—No. 2

Air Pressure and Springs Insure Safe Operation

By Edward Miller

Miller Machine and Mold Works

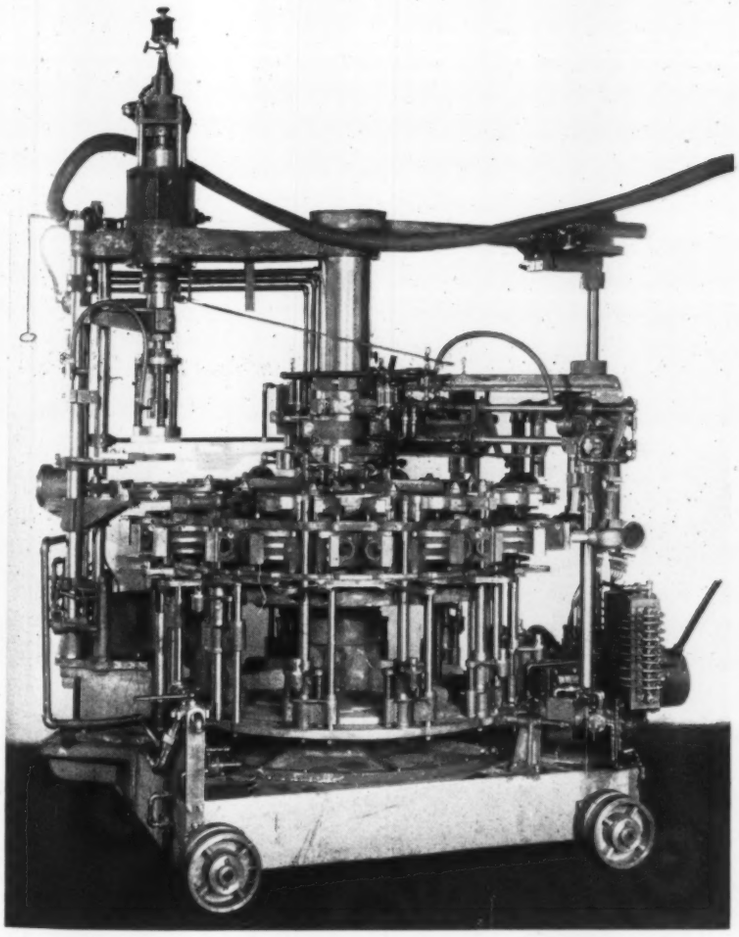


Fig. 1—Glass pressing and blowing machine, controlled largely by air cylinders, is capable of producing 30 to 35 articles per minute

FLEXIBILITY of compressed air and resiliency of springs effect a combination to which designers of automatic machinery have turned to insure safety in operation. Particularly pertinent is the glass pressing and blowing machine discussed in the following, which performs a multiplicity of accurately timed operations following a definite sequence. It is imperative that mal-operation be guarded against and if the glass should "hang up" at one station the unit must be able to function normally at its remaining stations. Accomplishment of this end has been worked out ingeniously and many of the ideas that are used may be of interest to designers in other fields.

Glass is an obstinate substance in its molten state and becomes even more difficult to control when it commences to cool. It was imperative that this factor be taken into consideration in planning the design and operation of each automatic feature. In the early days of glass blowing the artisan had only one or sometimes two molds to contend with and even

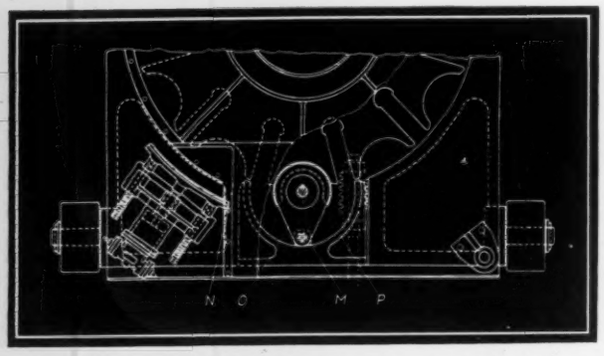


Fig. 2—A relatively square block instead of the conventional roller is employed in geneva mechanism

then he employed a helper. With the advent of the machine came the continuous process. Early machines were equipped with from two to five molds, the number increasing until today the Miller Machine & Mold Works, Columbus, for example, is manufacturing a unit, Fig. 1, with a capacity of twelve blank molds and twelve blow molds as one of its line of machines.

In this machine generous use has been made of springs to provide the necessary non-positive movement of certain parts. Compressed air, giving additional security, is employed to actuate the cylinders that are used extensively in the operation of the various mechanisms including the pressing head, blank molds, blow molds, takeout, etc. These cylinders for the most part have double acting pistons controlled by a unique timing device which will be discussed later.

To understand the principles of operation of the unit it is necessary to observe the various steps in the production of a glass article, which in this case is a fruit or packer jar. Referring to Fig. 3, the blank mold *A* and the blow mold *B* are mounted on the same vertical axis, the normal position of the blank mold being below that of the blow mold. As the geneva operated table carrying the twelve pairs of molds (shown in Fig. 6) moves around, the blow mold is opened by an air cylinder *Z* acting through a slide *M* and linkage to allow the blank mold to rise to the same level.

Springs Protect Mold from Damage

Beginning at the blank mold lifting station the blank mold is raised by an air cylinder on to a cam track on which it travels upwardly to meet the neck ring *H*, supported by holder *G*. The blank mold carrying arm *E* is equipped with two safety springs. If in raising, the blank mold should encounter some obstruction such as a piece of glass the springs would compress and prevent excessive pressure in the upward movement of the mold. This condition rarely arises; normally the blank mold moves freely to the next station by the indexing of the table. Here it receives its charge of glass. The proper weight of glass is measured by a feeder which while synchronized with the machine is not a part of it.

The next indexing stroke carries the blank mold to the pressing station where the glass is pressed into a cone-shaped parison as shown at the right of Fig. 6. The air operated pressing head equipped with a plunger *K* is depicted in Fig. 5. After the parison is pressed the blank mold drops from it to the position shown in Fig. 3, leaving the glass hanging in the neck ring *H*, by which the threaded portion of the jar has been formed. Blow mold bottom *C* moves into position and blow mold *B*, carried in cage *D*, closes around it and the glass parison.

Glass Article Removed Automatically

The glass then indexes with the table to the blowing stations which are equipped with blowheads *L*. One, two or three blowing operations are provided, depending on conditions, viscosity of the glass, size and nature of the article, etc. The blow heads are controlled by air in conjunction with the blow mold locks through a central valve. After the glass is blown and cooled the mold moves to the takeout station where the article is removed automatically and placed on a conveyor by which it is transferred to the tempering lehr.

Typical of the many safety features embodied in the unit is the method of preventing breakage of parts if the cam controlling the blow mold bottom slide *F*, Fig. 3, fails to be positioned properly by air cylinder *Y*. In early practice the bottom slide was actuated in its inward travel by a block on the piston rod. If the rod came only half way out, the block on the slide would strike

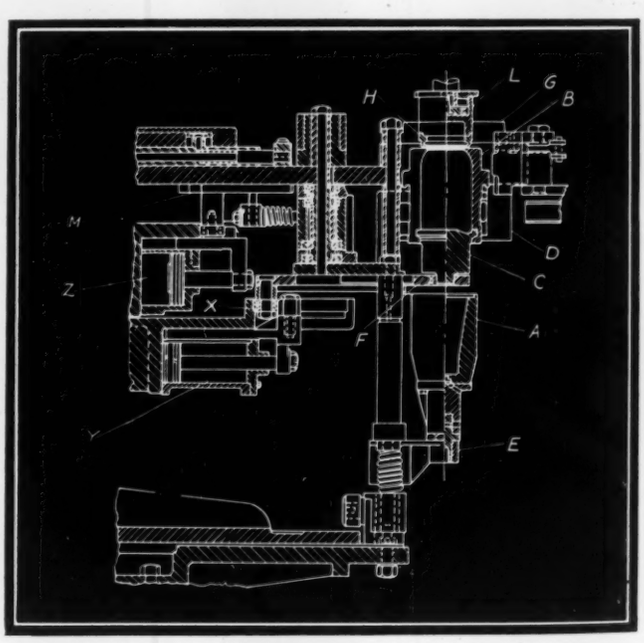


Fig. 3—The blank mold is mounted on the same vertical axis as the blow mold, the latter being split to permit blank mold to move upward within it

directly against the block on the piston rod as the machine indexed. To eliminate the trouble a cam, hinged at its forward end to the cam housing and on the other end to the piston rod, now is employed. If the piston rod should move only partly forward, the roller *X*, Fig. 3, which normally is drawn inwardly as it contacts the cam, would follow the cam without causing damage. By employing a cam of this type the machine is able to function without interruption if incorrect operation of the cylinder is caused by an eventuality such as breakage of an air line.

Portability is a feature considered to be outstanding in this type of machine, a roller bearing wheel being provided at each corner of the rectangular base. In view of this portability it was desirable that the source of power be embodied in the machine. An electric motor is installed adjacent to the intermittently revolving table which is carried on an 8-inch hollow steel column. The table is driven by a three horsepower

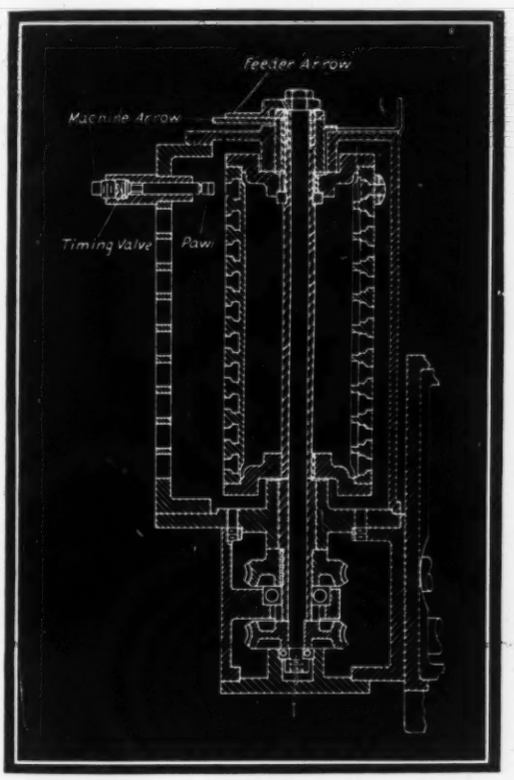


Fig. 4—Operation of various mechanisms is controlled by a timing drum and series of valves

motor which operates a geneva mechanism through a worm and gear. Redesign of this geneva mechanism solved a major problem which was causing some difficulty in overcoming the inertia of the two-ton revolving table. Older models revealed that after extended periods of service the sides of the geneva wheel slots showed a large amount of clearance which was caused by compression of the metal resulting from pressure of the geneva arm roller. The construction shown at *M*, Fig. 2, resulted.

Instead of the conventional pin and roller the block *M* is mounted on the geneva arm *O*. In operation this block engages the slots in the same manner as the conventional roller, but on entering each succeeding slot presents the opposite side to the face of the slot. Compression of the metal has been eliminated due largely to the fact that the surfaces of the block afford greater bearing area than would a roller. In order to keep the block in the proper position to enter the slots a guide *P* is provided. The flat surfaces of the block follow the face of the guide shown in Fig. 2. Little wear occurs on the surfaces of the block or slide due to the fact that the mechanism is built into an oil bath.

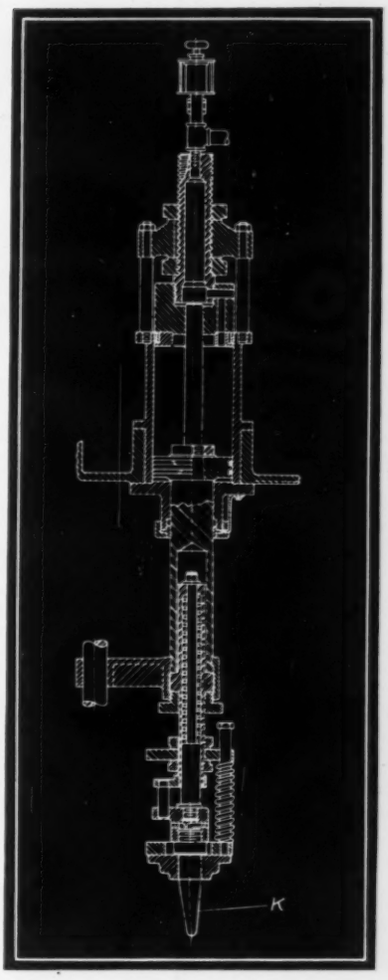


Fig. 5—Internal spring is employed in the pressing head to provide cushioned movement of plunger into blank mold. External springs on cap seal top of mold

Glass Feeder Synchronized With Machine

Because of the characteristics of molten glass and the factors which enter into the process of handling it in predetermined amounts at the discharge point of the furnace, special consideration is essential in feeding the glass to the machine. The unit has been designed so that it will be unnecessary to stop the flow of glass when the machine is shut down. The glass feeder, synchronized with the machine, delivers charges of glass of a predetermined volume to the blank molds. Stoppage of the feeder would result in solidification of the glass which would cause difficulty in obtaining measured amounts when the feeder again starts. To effect continuous operation of the feeder its shaft is connected direct to the drive shaft, while the machine is controlled through a clutch. When the clutch is disengaged

a deflector trough conducts the charges of glass away from the machine, operation of this plate being automatic through an air cylinder which is actuated by a control valve when the machine stops.

By the unique arrangement employed for starting and stopping the machine correct timing with the feeder is obtained. The machine is thrown into operation manually through the clutch when two arrows, shown at the top of the timing device in Fig. 4, are in line. The top arrow on the solid shaft is connected by gearing to the feeder shaft while the bottom arrow is keyed to a hollow shaft which obtains its motion through a miter gear on the drive shaft for

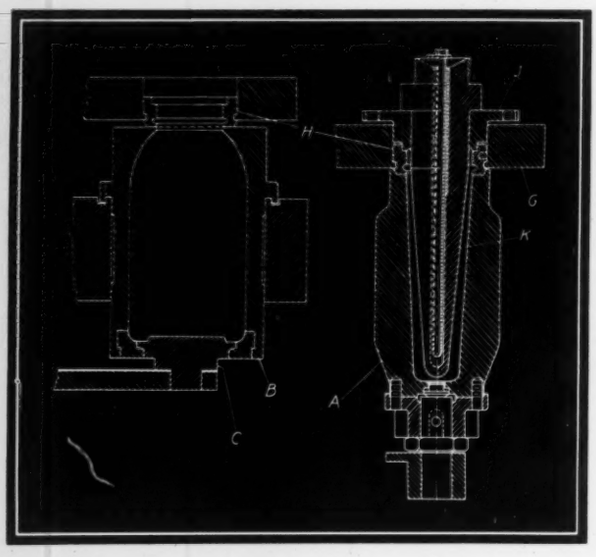


Fig. 6—Blank mold with glass parison is shown at right and blow mold at left

the machine. It is essential that the machine and feed keep in time, otherwise the glass would not be discharged from the feeder at the point where the mold stops.

In order that each compressed air cylinder shall function at its proper interval the timing device, Fig. 4, is provided. This arrangement embodies a grooved drum on which buttons are mounted at an angle down the side of the cylindrical surface. As the drum rotates each button is presented in turn to its respective pawl which controls a timing or pop valve in the air line. The upper valve only is shown in the drawing. Each end of a main valve which is actuated by the timing valves is connected with the end of the cylinder it controls. At the center of the main valve air at a constant pressure is applied continuously. One button will cause the core in the valve to move one way thus giving vent to the air which flows through the opened orifice to actuate the piston from one end. When the moment comes for forcing the piston in the opposite direction another button on the timer trips its pawl to force the core in the opposite direction and thus allow the constant air pressure to follow its designated course through the line.

Typical of the operation of a cylinder as discussed in the foregoing is that of the pressing head shown in Fig. 5. Here again a spring serves to afford non-positive cushioned movement. If the charge of glass in the mold should exceed the intended amount there would be danger of cracking the mold or causing the glass to force its way out at the top. To obviate any difficulty from overpressing, the spring is employed to take up the difference if necessary after the glass has filled the cavity between the plunger and the mold. Three springs arranged about the outer edge of the pressing head hold the plunger ring firmly down to seal the top of the mold.

Air Cooling Provided for Molds

Cooling of the blank molds is accomplished through channels connected with orifices in the supporting column, blasts of air being directed against the blank molds. To cool the blow molds a semicircular wind drum is mounted on the side of the machine having a separate connection with the air supply. Holes in this drum correspond to openings in the mold cages and as the table stops during its intermittent travel air is blown through internal channels in the cages, thereby cooling the blow mold and the glass article uniformly.

In the operation of the takeout, an air cylinder actuates two jaws that fit around the threads at the top of the jar as it rests on the bottom of the mold after the mold sides and cage have been opened up. The timer discussed previously actuates the valve for another cylinder which carries the takeout jaws outwardly to the conveyor, where the jaws are released and the article depcsited.

Assists in Stopping Table

Considerable momentum must be overcome in stopping the two-ton table at the end of the indexing strokes which occur about 35 times per minute. To assist in bringing the table to rest an air operated brake is provided as shown in Fig. 2. At the proper moment a button on the timer opens the valve which admits compressed air to the piston of the brake cylinder and applies the brake. Compressed air required for this machine to operate the cylinders and perform the blowing is 30 to 40 pounds, and low pressure fan wind is employed for cooling.

Mechanical devices such as cams, etc., could be worked out to effect practically all of the various movements in this machine but the arrangement would be highly complicated as to number of working parts and method of operation. Therefore pneumatic units have been employed throughout and a high degree of simplicity and compactness obtained.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Oxygen Jet Serves as Machining Tool

ENGINEERING is witnessing important changes in the methods of forming, shaping and machining of metals. These innovations in some cases are effecting radical changes in design, making it exceedingly necessary for the designer to keep informed of progress. One of the more recent developments is flame machining. This involves the use of the gas cutting blowpipe which already has effected wide economy in producing torch cut parts (M. D. Jan. p.11).

In the substitution of the oxygen jet for the cutting tool is seen the possible simplification of the machine tool as it is known today. The power to drive the unit would be reduced considerably and the speed with which the metal is removed can be increased. As brought out in the December issue, page 40, research work has been in progress for some time. Planing, turning, grooving, centering, milling, drilling etc., have been accomplished satisfactorily.

The new process as outlined in the November *Oxy-Acetylene Tips,* published by Linde Air Products Co., New York, is an offspring of the oxy-acetylene cutting principle. Primary distinction between flame cutting *a* Fig. 1, and flame machining is the use of a tangential positioning of cutting oxygen stream shown at *b*, Fig. 1.

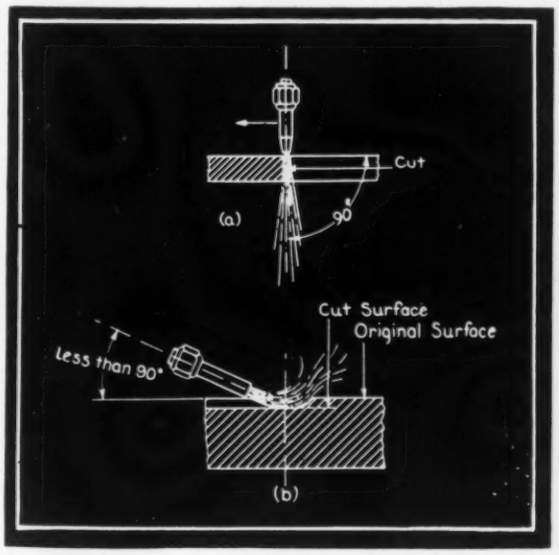


Fig. 1—In flame machining the flame is positioned tangentially with respect to the work

A simple application of tangential cutting under compound lathe motion is shown at *A*, Fig. 2. The metal was removed by a single pass of the cutting oxygen stream. Individual threads or races can be deepened by repeating the operation concentrically and by adjusting the cutting nozzle and the velocity of the oxygen.

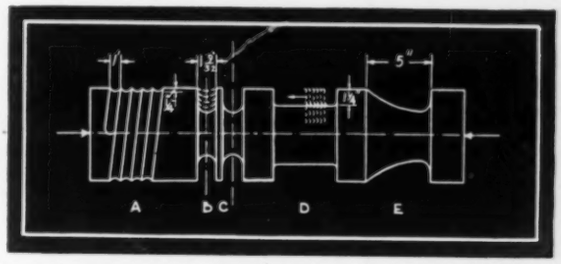


Fig. 2—Multipass planing will produce grooves readily. Flexibility of process is illustrated at E

Cuts shown in the same figure at *B* and *C* are milling cuts readily produced by multipass planing. The cut at *D* indicates a range of single pass cutting produced by a compound angle setting of the gas stream. For cuts of this type the axis of the cutting nozzle is made tangent to both the surface of the stock being cut and the desired vertical face of the cut to be made. Such cuts are started first by milling a slot similar to *B* as shown dotted at *D*, which provides an opportunity to apply the compound setting against either wall of the milled slot.

Cut *E* is a modification of *D*, illustrating roughly the flexibility of flame turning. In this case the contour of the cut has been changed by means of a rotating action applied to the cutting nozzle while the work is rotating. From these experiments it was obvious that, having suitably sensitive and flexible mountings for the cutting devices and feeds, any desired profile could be produced. It was further observed that the responsiveness of the material to the cutting operation was, in a large measure, proportional

to the temperature of the material in the region of the cutting zone. In other words contour, uniformity and flexibility of flame machining are allied closely to the temperature of the work and improve as temperature increases. A detail of *C* and *D* of Fig. 2 is shown in Fig. 3.

Impact extrusion is another process which deserves study. Aluminum is being worked into unusual shapes by this method, defined as a squirting operation requiring heavy machinery of special design. Extremely high pressure is required to make the metal flow. Presses used in the Hooker development for the production of tubing, employ an extruding and a trimming punch mounted on a slide which shifts to allow first one and then the other to enter the die. Following the extrusion stroke, during which the metal flows down around the point of the punch through an opening in the die, the tube is left in the die with a thin shoulder section. On the subsequent stroke the trimming punch shears off the shoulder, pushes the tube through the die, and lifts out the ring of scrap.

Roll forming of metals also is making strides. As the name signifies, cold forming is the production of parts of cylindrical section by rolling a casting, tube, or rod between two rollers, or by rotating and simultaneously forcing them into close contact with a single rotating roller. Contact causes transformation in the plastic condition of the metal under stress. A handwheel can be rolled from an aluminum blank in two minutes by this process. Elimination of machining is one of its chief assets.

Fig. 3—Comparatively smooth surfaces may be produced by the flame. Cuts C and D in Fig. 2 appear as in this photograph

Rolling Threads in Metal Caps

MACHINES for capping and sealing containers involve various ideas, typical of which is the patented method of rolling the threads into the cap, employing the threads of the container top as a matrix. Producing threads in this manner is economical where conditions permit, producing an airtight yet easily removed re-closure cap. Such a method has been developed by Aluminum Seal Co., New Kensington, Pa., which recently designed a machine incorporating this principle of rolling threads for container caps. According to J. E. Sharp, vice president and chairman of the market research committee of the company, it was necessary to devise a unit that would follow the required sequence of operations rapidly and without interruption.

The head of the unit, Fig. 4, embodies features in design that are of particular interest at this time in view of the probable change in prohibition laws. Pressure block *A* compresses the liner *B* in the cap, forcing it into the irregularities in the container top. The next step effects the forming of threads while the tight seal is held under pressure. To accomplish this

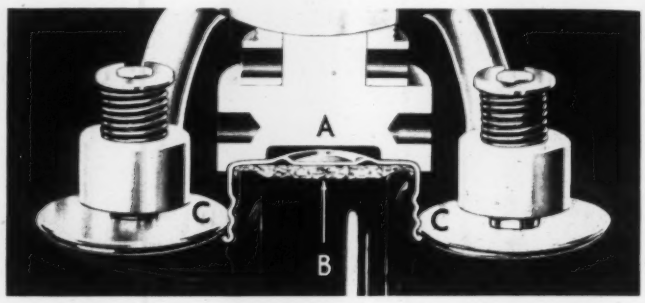


Fig. 4—Threads of container top are employed as a matrix in machine developed for capping and sealing containers

rollers *C* are used. These are mounted so that the roller assembly revolves around the pressure block while the block is held stationary, exerting pressure to seal the closure. Rollers always are returned to their top position by a light spring.

In operation the cycle begins when the cap is placed on the container either by hand or by automatic feed from a hopper. When the container comes under the capping head it is forced against the pressure block, being centered through a guide bell. After the cap is seated properly the rollers are brought against it by means of a cam. These rollers indent the metal on a plane just below the beginning of the thread on the container. As the roller assembly revolves around the stationary cap, the rollers naturally follow the thread to a point where it runs out, thus producing a similar thread on the cap. To compensate for variations in container heights and for out-of-round conditions the top pressure and the pressure on the rollers are controlled by springs.

Measuring Stress with Portable Unit

APPARATUS for the measurement of stresses by the photoelastic method (M. D., Nov. 1930) has progressed now to the stage where it shortly will have an influence on the

everyday routine of designing machinery. Indicative is the introduction of a practical polariscope by Robert E. Kinkead Inc., Cleveland. This device is portable, having a camera at-

Fig. 5—Practical polariscope designed for everyday use is small enough to fit in the pocket

tached, and is small enough to fit in a pocket.

The instrument, shown in Fig. 5, is constructed on the well known principle of plane polarization of light by use of black opaque reflectors. Projected area of the reflectors is approximately ⅜-inch diameter. Light source for visual inspection is a frosted bulb on an ordinary flash lamp.

In many cases the device is adaptable for use as a strain gage. For this purpose a celluloid or bakelite specimen is attached to the member on which strain gage readings are wanted. The polariscope is fastened to the transparent model. Illumination is supplied by flash powder with the light filtered through a colored lens. An ingenious camera attachment is made so that the stress concentrations around a notch 0.0035-inch wide may be photographed. Comparison with calibration photographs permits reasonably accurate determination of the strain, where the transparent specimen is made rugged enough to stand field service.

Diaphragm Replaces Ball in Valve

COOLANT control in the automobile radiator has become a significant factor in the protection of the engine block and head from cracking. Higher speeds with more sudden stops cause the cooling water or antifreeze to surge forward into the top of the radiator and spurt out through the overflow. Free wheeling also sets up a condition which affects the cooling system. When the car is running out of gear, so to speak, the engine slows down and likewise the water pump. Steam is created which forces water through the overflow pipe.

The natural solution to this type of problem is, of course, a control valve on the overflow pipe. Accordingly the Illsley Co., Detroit, developed a control unit, Fig. 6, to keep the overflow pipe normally shut off, but to open it automatically when the engine is working under so much load as to create an abnormally large amount of heat and tax the radiator beyond its proper capacity.

Simplicity characterizes this new invention. By the use of a ported diaphragm, Fig. 6, greatly increased pressure area is provided and balls, poppets, springs or weights are eliminated. Only 3 inches in diameter, the unit is small enough to be installed without interfering with the fan. Arrows in the drawing indicate the path of flow through the valve whenever sufficient pressure has risen to lift the diaphragm and permit discharge.

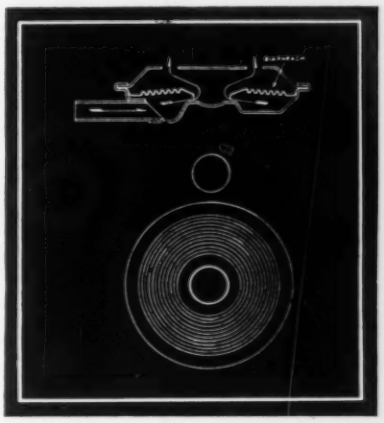


Fig. 6—Coolant control forms pressure system for retaining coolant in automobile radiators

The idea discloses an effective means of overcoming the hazards of rust and corrosion which play havoc with the ordinary poppet valve.

Opposed Free Pistons Are Synchronized

THOUGH the free piston pump or compressor has attracted inventors for the past generation the only highly successful machines with flying pistons are pneumatic and steam hammers. A great number of the free piston devices that have been suggested, excepting the single instance of slow moving pumps, have failed because of the terrific impact that takes place when the cushioning element for some reason wears or misfunctions.

Typifying the idea involved, which is being employed in a European free piston oil engine compressor without connecting rods, valves, spark plugs or flywheel, is the unit depicted in Fig. 7. J. Gould Coutant writing in a recent issue of *Power* describes the operation as follows. The two opposed free pistons slide in and out in synchronism, insured by a lever pivoted at its

center and connected by side rods to the two pistons. These rods do not normally transmit power; their work is merely to absorb the slight incidental variations in the operation of the pistons and keep them in step. The oil pump, however, is operated by this mechanism.

In effect the pistons are free of mechanical connections and act as engine pistons on the inner ends and as compressors on the outer ends. All power is produced in space *C*, according to the diesel two-stroke cycle. Fuel oil is injected at *B* in proportion to the load.

A coil spring (not shown) is cranked up for starting. The two pistons are driven together

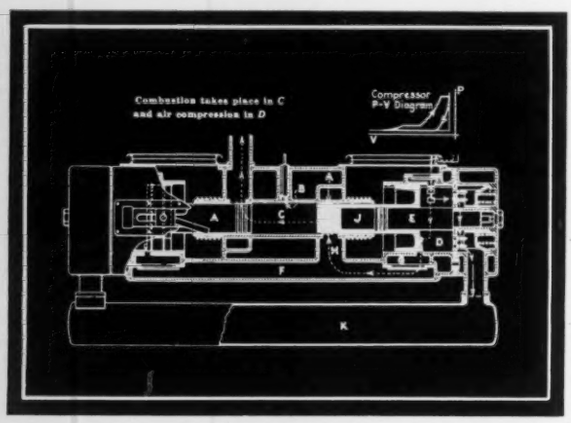


Fig. 7—Free piston oil engine compressor does not use connecting rods, valves, spark plugs or flywheel

by the action of this spring, explosion taking place at the proper point and forcing them out. This outward movement compresses air in the annular spaces *D*.

During the first two stages of compression part of the air is bypassed through the plate valve *G* and acts as scavenging air, passing through *H* and into combustion space *C* and out through the exhaust. As the stroke continues, the bypass port is closed and the air pressure builds up for delivery to the receiver *K*, from which it passes to the outside application.

Compressed air locked in space *J* by the secondary fixed piston *E* acts as a cushion to insure return of piston *A*, regardless of the load on the compressor ends. All these actions, of course, take place simultaneously at both ends of the machine, which is symmetrical in all respects.

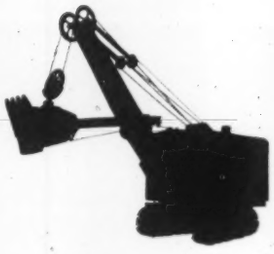
The Engineer's Place in the Recovery

TODAY there are too many people who are praising the golden age of the past, forgetting that in those "good old days" leisure and comfort for the favored few were afforded by the drudgery of many of their fellow human beings, according to Dean A. A. Potter, president of the American Society of Mechanical Engineers in a recent address. Sir Arthur Salter, the great English economist, states that even during this period of world depression more people work and live in comfort than was the case a quarter of a century ago. Science and engineering have placed a new valuation upon human rights by eliminating drudgery and by substituting mechanical power and machinery for human labor. At present our problem in highly industrialized lands is not human slavery, but too much leisure, *idleness* due to the unbalance which exists between production and consumption. While the present unemployment conditions are to be greatly deplored, it should be realized that about half of those who are now employed in our large cities are working at tasks which were absolutely unknown 55 years ago.

Engineer Is Not Responsible

While the engineer should not be held responsible for the present economic chaos, for the use which is being made of his creations, or for the failures in the fields of social and economic relations, it may be well to appraise the present trends in engineering profession of this country as they affect industrial recovery and general well being. It is gratifying to be able to report that the activities of the engineering profession of this country in connection with the present readjustment period have resulted in a general opinion that the present economic unbalance can be corrected mainly by engineers. Stuart Chase, in his *New Deal,* states that the real work, the real thought and the real action in connection with recovery must come from engineers, "That class most able, most clear-headed of all in American life." The engineer, who has contributed materially to the improvement in the physical conditions of people, is challenged to bring about a better economic order by taking more active part in solution of the problems which affect the civilization which he has created.

We have no reason to despair either about the future of this country or about the opportunities ahead of our engineering profession. Temporarily there is an economic unbalance the world over, but American genius which is responsible for more than two-thirds of the epoch-making inventions of the past 60 years, coupled with the good sense of our people not to be carried away by false doctrines, will result before long in more general well being than ever before, and in this recovery the engineer is bound to play a most prominent role. Absolute faith in our country's future, in humanity and in our institutions is one of the most pressing needs of these days of readjustment. We must remember that this country has passed several distinctive periods of industrial depression and always came out greater and more prosperous than ever before.



Road Machine Builders Simplify Control

DISAPPEARANCE of the large hand wheels and cumbersome cranks in road building machinery, at which the operators work industriously in order to effect adjustments, is presaged by the latest equipment presented at the recent exhibition of the American Road Builders association in Detroit. The trend is toward hydraulic controls or a separate motor with which adjustments in operating parts of the machines can be made much more quickly, easily and accurately than heretofore.

In the hydraulic control system, such as the one employed on machines of Galion Iron Works & Mfg. Co., every necessary adjustment is made by the movement of a number of short range levers. Power is supplied by a small single cylinder 4-cycle gasoline engine of 1500 revolutions per minute which operates the pump supplying oil to the various cylinders. To facilitate ease of control further, the levers for operation are grouped directly in front of the operator. In addition to the adjustment of the scarifying teeth, blades, tilt of wheels, etc., the hydraulic control also operates the steering gear.

Power Take-Off Is Applied

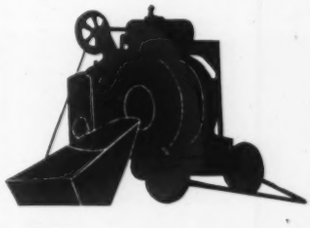
A few of the larger machines employ a separate gasoline motor for the control of their equipment, but this expedient is applicable only where considerable labor is necessary in making adjustments. A more frequent design development is the utilization of a power take-off unit to transmit power from the tractor hauling the road building equipment to the operating portions of the machine.

The J. D. Adams Co. uses a power take-off which is connected to the tractor crankshaft and fastened to the tractor through the same bolt holes as the back cover plate. Other applications may be made with the take-off on the front of the machine for use with equipment such as snow plows which are pushed ahead of the tractor. Power is transmitted from the take-off unit to the machine by universal joints and auxiliary shafts or by V-belt drives which actuate a main shaft of the machine.

Welding of frames has not progressed to any great extent in the design of road machinery. However, Cleveland Tractor Co. has replaced bolted or riveted channels and supports with pressed steel sections fabricated by welding. This company has also employed drop-forged alloy steels in assemblies formerly made up from castings. The use of alloy steel or high test cast iron is general, inasmuch as the equipment must be constructed to withstand considerable rough usage.

Employing Anti-Friction Bearings

Anti-friction bearings are being employed in increasing numbers. The types in general use, however, must be sealed against grit and dust in themselves or have an efficient seal provided on the machine. The latter method is the one most generally accepted, and the manufacturers



have taken every precaution so that the service provided by these bearings will be the maximum possible.

Manufacturers of road building equipment are vitally interested in the activities of the association which is actively working to prevent further diversion of gasoline tax funds away from road building and further curtailment of maintenance budgets. It is said that abandonment of maintenance on the many roads which are not hard surfaced would result in complete destruction of the surface within sixty days and require rebuilding. Such an abandonment by many states would seriously curtail the requirements for maintenance machinery, while reduction in funds for building new roads would limit the market further as it is possible to construct a concrete or black top surface completely by machinery.

Considering Design from the P

By Harold F. Shepherd

DESIGNERS who are planning the use of welded parts or structures are concerned primarily with the matter of getting the separate parts of the assembly into proper form preparatory to welding. Tubes, plates, hot rolled shapes, cold rolled and drawn shapes are available. Adequate tools may be obtained for cold or hot forming of plate to meet many requirements, but costs mount rapidly as the amount of forming increases. Great ingenuity often is required to insure pleasing appearance without spending too much for forming operations. The cases cited in the following show how several problems of this nature have been solved.

Clean Metal Is Exposed

A thin walled tube projects from the vessel in the design shown in Fig. 1. It was feared that direct welding might burn or groove this tube. To overcome this the torch was played on the little turned projection *a* until it fused with the tube. This has been an extremely successful method. The tubing is polished at the weld to expose perfectly clean metal. Fig. 1 also illustrates the manner in which a seal may be welded into a small turned and bored job. The edges of vessel and plug are turned sharp and fused together with a small torch, a possibility with close fitting clean metal assemblies.

A similar result is accomplished by the resistance welder operation Fig. 2*A* in which the job is held in a copper die resting on a machine table and traversed against a rotating copper wheel.

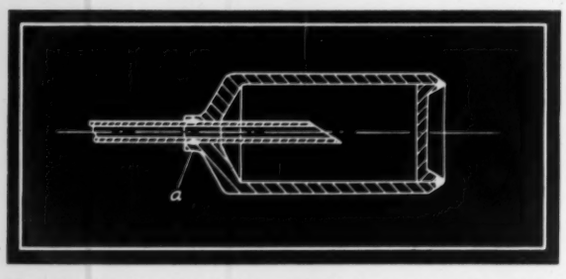


Fig. 1—As direct welding might burn the tube, torch was played on turned projection a

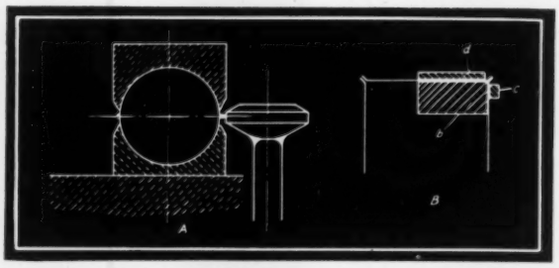
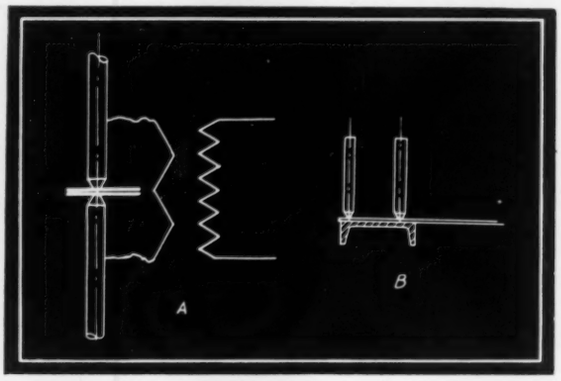


Fig. 2—(Above)—Well-designed jig often aids the success of fabricating operation. Fig. 3—(Below)—Job resistance is secured by perfecting contact over a small area only



Smooth pickled stock should be used for this type of work.

The jig is partly responsible for the success of Fig. 2*B*, as it often is in similar work especially in autogenous welding of thin sheets. It should be adapted not only to hold the component parts of the job in proper relation but also to conduct heat away and prevent buckling. Thus the seam in Fig. 2*B* is made on table *b*. The band *c* holds one sheet against the table edge and the weight plate *d* on top holds the other down. The sheet is blued very little beyond the weld and buckling is avoided.

The spot welder operates as shown in Fig. 3*A*. The job resistance is secured by perfecting contact over a small area only. A new development uses two points side by side as in Fig. 3*B*. The current is forced to take a path through the lower and heavier member by the great increase of resistance between the points when the thin sheet reaches a high heat. This welder is adapted especially to sheathing a heavy welded structure.

Spot welders will operate on metal up to 1-

the Production Standpoint

Part III—Welding

inch thickness but often it is desired to effect welds on a less expensive machine and at the least operating cost. Projection welding, Fig. 4, accomplished by embossing the surface to secure definite focus of the heating current, solves this problem.

May Employ Roller Contacts

By replacing the points of the spot welder with roller contacts, one roller being geared, the automatic lap weld seamer is available to replace by a single operation the folded and soldered lock joint process. Where the lap joint is objectionable a similar operation may be used to weld a butt strap over the seam. Butt welding is accomplished in like manner by two electrified rollers.

Flash or butt welds in which two pieces clamped in two copper jawed vises are contacted and pressed together when plastic also are made without added metal, in fact metal is extruded at the weld, or the junction may be upset as the parts are forced together by the machine. Such welds may be swaged to improve their quality. Here it is essential to have equal areas adjacent to the contact point in order to make the electrical resistance of both pieces equal. Thus link head Fig. 8*A*, a drop or machine forging, is drilled or pierced to reduce its cross section at the weld to that of the tube. The forged flange shown in Fig. 8*B* is spigoted at its junction with the tube.

Should Collaborate with Machine Builder

Special resistance welding machine design has reached the status of an industry. Chain, wheels for agricultural machinery, automotive products and other specialties too numerous to mention are produced by automatic machines making one weld or as many as required at each machine cycle. Naturally products of this sort should be designed only by collaboration with the designers of the welding machine.

Fillet or butt and vee welds are too familiar to need description except to repeat a precaution. The form of fillets should be specified on the drawing and templets should be provided. The unit strength and ductility of deposited metals are reduced, which makes it evident that the amount of material in the weld is important as a dimension. The nature of its introduction and its more popular uses have led many to regard autogenous welding as a hand process. Like all other manufacturing operations it must tend eventually to become much mechanized and all design efforts should be bent scrupulously toward this end. Naturally this will confine the simpler and commoner welding operations to straight line seams, as in the skid Fig. 6, and girth or circular seams. Full or semiautomatic equipment is available for both of these type of operation.

The line seamer travels on a track either inside or outside of the job or the job travels before the welding head. Girth seam work is merely rolled before the welding head. The carbon arc seam is made by puddling into the joint a rod of suitable material disposed as at *e* in Fig.

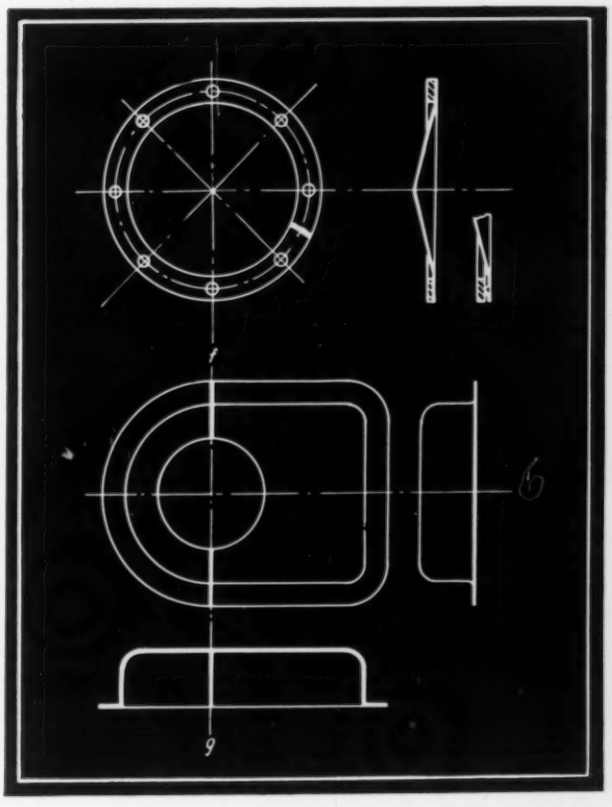


Fig. 4—(Upper)—Surface is embossed to secure definite focus of the heating current. (Lower)—Spinning and flat projection methods may be combined advantageously

6. For the metal arc seamer the rod is carried on a reel and fed automatically to maintain the arc.

An example of design for welded machine parts is shown in Fig. 7. This is a rig front for oil well pumping. It comprises countershaft with chain drive to a main shaft carrying a crank for pumping, a tug wheel for rope drive to the bull wheels and a chain sprocket for the calf wheel or hoist. The countershaft is provided with friction reverse and brake. This combination replaces individual countershaft and crankshaft units framed originally in open structural steel. Adjustable centers, self oiling and complete enclosure of bearings and chain are provided with moderate weight in a practically indestructible housing.

Sheared Plates Are Employed

It will be noted that the box girders are simple sheared plates, the only cutting being at the bearing seats. Practically all of the seaming may be done on a line seam welder and positioning of the job is facilitated greatly by its oblong form.

When the forming of heavy plates and shapes is absolutely unavoidable, machinery is desirable but not essential. Cutting may be done with arc or torch.

Where form and stiffness are required rather than great ductility and shock resistance the flanges of shapes may be cut out, the webs only being bent after which flanges may be restored by rewelding. This expedient lightens the work tremendously.

The flanges of shapes should not be machined.

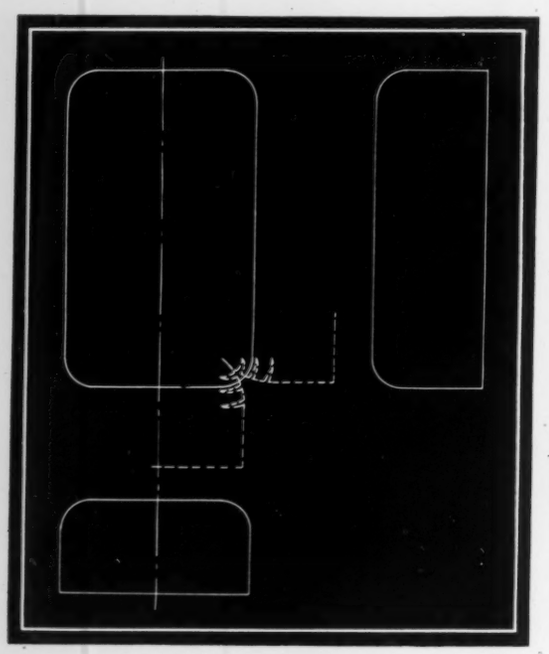


Fig. 5—Almost any required form can be produced with simple tools by welding

The original sections are too well proportioned to be altered without effect on both strength and appearance. The slight warping and misalignment possible in work made without costly jigs seldom allows machining without variable flange thickness. For this reason and to reduce machining time all seats and pads should be welded on as in Fig. 6.

Welding jigs for large jobs may be avoided

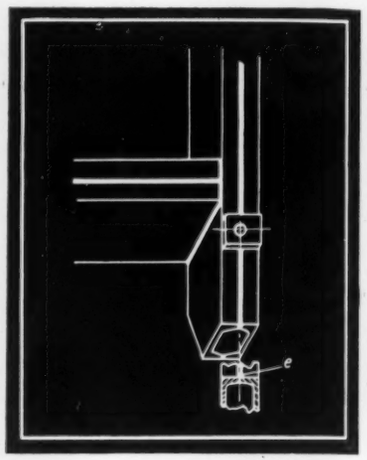


Fig. 6—Channels are welded together by the arc method to form rectangular box section

when economically necessary if it is convenient to drive a few rivets to hold the job together for welding. This practice does not have the approval of purists in welding design but it nevertheless is an economical and practical expedient of some popularity.

Use of structures combining cast and rolled steel by welding broadens welded design possibilities immensely. Box frames of steel are cast in skeleton. Pressed or plate steel panels are welded in to stiffen and enclose. Such panels should be bumped to relieve thermal stresses due to welding and to raise or otherwise control the frequencies which they may develop as noise transmitting diaphragms.

Automatic Welding Head Used

Ports and valve chests as for steam turbines are provided in cast form and welded to steel casings. The girth welds are made automatically by using a metal arc welding head in a boring mill much as a cutting tool is used. For this purpose a special speed reduction is required, however, and it would seem that welding machine tools in great variety and of lighter and less costly construction than cutting machine tools must soon be available.

The designer who wishes to use stampings yet cannot because of the small quantities demanded may avail himself of welding to produce almost any required form with simple tools. A case of this sort is the hood shown in Fig. 5. This might have been drawn on a press but actually was made by flat development and weld-

ing. The sheet layout is indicated in dotted lines.

The orange peel corner development is most difficult. It might be calculated nicely but since it forges a little while forming and some space is required for the welding material, it is better to let the welder work out the form and number of gussets and turn them in to be recorded on the tracing. The corners may be formed on an ordinary cast iron stake of the correct radius and welded while in contact with the stake. They are finished by a little hammering and grinding, the job appearing seamless when completed. No. 14 B.W.G. black sheets work nicely for this purpose, although No. 18 sheets are preferable at some times as they are lighter. No. 20 may be used by skilled men. Full pickled, cold rolled metal is preferable for lighter work.

May Apply Spinning Process

When the cover required is a figure of revolution as in Fig. 4 the spinning process may be applied to parts of almost any size. Metal spinners are not numerous in these days but they still ply their craft in most cities. Their tools are simple, a lathe much like a wood turner's, face plates of cast iron formed like the inside of the piece to be made and a few long handled ball nosed bars used to shape the disks of metal. The rim is butt welded and then spot welded to the sheet.

Fig. 4, lower, shows what might be done by

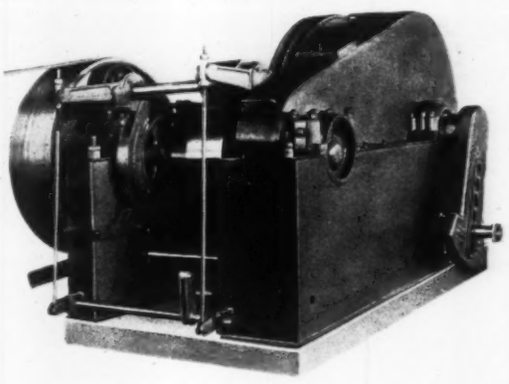


Fig. 7—Box girders are constructed of simple sheared plates. The only cutting is at bearing seats

combining spinning and flat projection methods. The section to the left of line *f-g* is spun in basin shape and cut in two. The section to the right is made in the same manner as the hood, Fig. 5, These parts are joined by welding, hammered and ground so as to appear seamless in the finished form.

The use of welding for jig and tool work has much to commend it. Lugs are less fragile and the whole structure will stand more abuse. Jigs usually are designed but once for immediate use. There is no experimental stage after which the designer may correct his first effort. The welded jig does, however, offer opportunities for change without loss.

Use of torch or arc for cutting plates and billets to shape is a practice so convenient and economical that it must be accepted. However, it is the engineer's privilege to require that these operations be conducted properly. It is not possible to melt a portion of a cold piece of steel without introducing thermal stresses beyond the

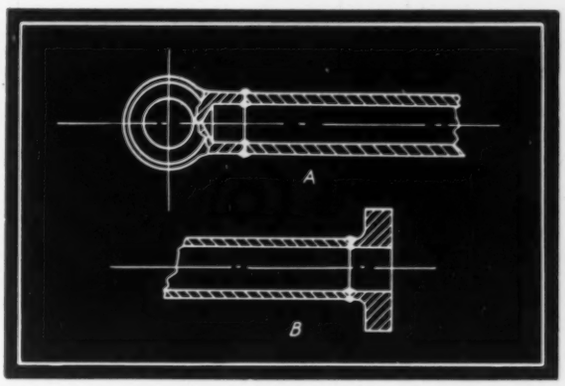


Fig. 8—Forging is drilled to reduce cross section at the weld to that of the tube

elastic limit at some level in the temperature gradient. Plates cut in the yard in winter weather have been broken by a tap of the inspector's hammer, not once but repeatedly, even regularly. Marine line shafting cut with the torch when cold has broken in the keyway en voyage.

Steel Should Be Warmed

In particularly cold weather, therefore, warming the steel is advisable for thick work, and most cut or welded jobs required for machines in which safety or continuity of service is important should be heat treated. Heat treatment of steel castings and forgings, if only annealing, is a universal requirement. Certainly it is no more than fair to give the welded job an equal chance to prove its merit.

The same care should be used in placing welds as is directed to the junctions of structural members in bridges and buildings. Welds in beams should be placed at points of maximum shear and zero bending where possible. To avoid compound stresses, due to welding or deflection under load, junctions should not be too stiff. Little or nothing is gained by transmitting beam stresses to columns by too rigid attachment.

Acknowledgment is due to Fred Stanley, chief engineer of Oil Country Specialties Mfg. Co., Coffeyville, Kan., for the illustration of the rig front embodying his ideas of machine welding.

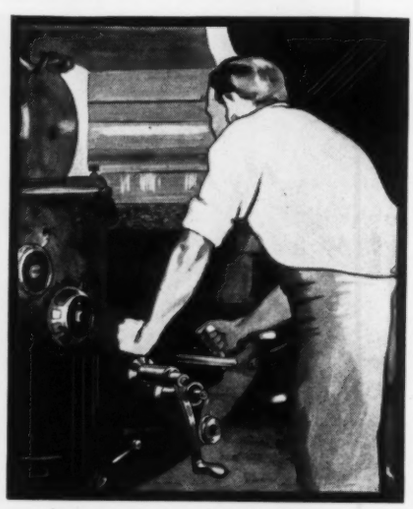
Are Shop Changes Imminent?

Necessity Plays a Part in Utilization of New Production Methods

JUST as welding has been accepted, so may other processes become established in the near future. Roll machining and flame machining, discussed elsewhere in this issue, are two of the methods that present possibilities. It has been said that flame machining, if developed further, may be the means of altering to a marked degree the design of machine tools as they are known today, and while this statement is hardly credible in its broad sense there is every likelihood that at least some of the existing types of machine tools will be affected.

It is difficult to foresee whether such a change, assuming it takes place, will have a material effect on the design of parts to be produced on these machines. Alert designers, however, are keeping closely in touch with probable radical changes. As stated by R. E. W. Harrison in discussing progress in machine shop practice at the recent annual meeting of the A. S. M. E. this present period, characteristically in line with previous somewhat similar ones, is prolific in hard thinking. This in turn involves consideration of improved tools and methods that in other times might receive scant attention.

Many recent developments in conventional machine tools have evolved around the growing use of cemented carbide cutting tools. Greater rigidity, strength and accuracy of manufacture is required to take advantage of the higher speeds at which these tools will function. Lack of need for increased production, high cost of the tools and limitations in their use have militated against their universal employment. It is not surprising therefore that research work has disclosed another cutting alloy which will market at many times less than cemented carbide tools. The new alloy is said to possess characteristics midway between these and high speed steel tools and to be capable of cutting iron and steel.



In the previously mentioned report of progress in machine shop practice are brought out a number of points worthy of the consideration of engineers responsible for design. Emphasis is laid on the fact that concurrent with the development of more efficient machine tools and cutting elements there has been a rapid increase in the quality of work turned out by up-to-date forging machinery. In many instances work now is passed direct from the forging machine to the grinding machine without intermediate metal-removing operations. While investment in such forging machinery necessarily is heavy, results are economically attractive where work must be turned out in large quantities.

Heavy Grinding Cuts Permissible

Grinding machines capable of taking heavy cuts such as would be necessitated by the foregoing procedure are available, the amount of horsepower to the wheel having been increased to cope with the more arduous conditions of service to which these machines now are put.

Development of a lapping machine similar in principle to the centerless grinder in progressing rapidly and if this machine is successful its effect will be far reaching in establishing new standards of surface quality. Some of these machines already are undergoing production tests.

When it is realized that the average machine tool actually cuts metal only about 30 per cent of the total working hours, the importance of developing automatic loading devices or other means of reducing setting up time can be appreciated. Recent introduction of an idle time recorder undoubtedly will prompt increased efforts in this direction by bringing into more significant contrast productive and nonproductive machine time. This recording device also will be helpful in the elimination of idle time due to breakdown, lack of stock, etc., as all production losses are noted.

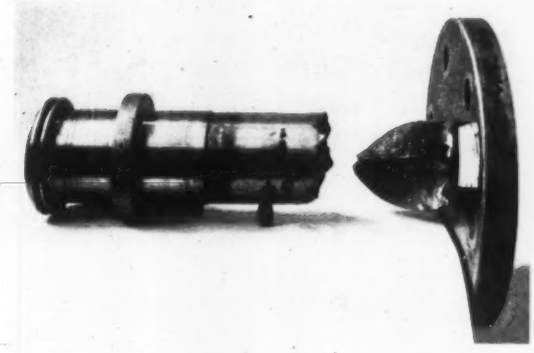


Fig. 1—Typical failure under variable torsion stress. The 45-degree cracks point to failure in planes of maximum stress

By C. R. Soderberg

Service Conditions Control Permissible Stress

CERTAIN fundamental aspects of the problem of strength and safety of machine parts must be considered in selecting working stresses. Mr. Soderberg, manager, turbine apparatus division of the Westinghouse company reviews these principles and suggests methods of selection in this abstract of a paper presented at the annual meeting of Mechanical Engineers.

MECHANICAL strength is one of the most important considerations in the dimensioning of machine parts. The designer arrives at a practical solution of this problem by an appraisal of the conditions of service insofar as stress is concerned; an appraisal of the strength of the materials under these circumstances; and a decision as to the margin he is willing to allow between actual service conditions and failure. This last decision is expressed through a set of conventions and rules for establishing working stresses, that is, a condition of service which, with regard to the limitations of the strength of the materials, gives the desired insurance against failure.

In endeavoring to define the strength of a material, it is important to remember that strength can be defined only against the background of a certain arbitrary method of testing. In general, this method of testing discloses some form of "failure," which is then selected by the designer as the contingency against which he wants to guard. In a few rare cases the conditions of test happen to agree rather closely with the conditions of service; this happy state of affairs is a rare exception, however. Most frequently the appraisal of strength for a certain actual condition of service represents a wide extrapolation from the conditions of testing.

Testing Art Is Extensive

The art of testing the physical properties of engineering materials is an extensive one, but there are only two tests that can be used directly for predicting failure quantitatively, if the word failure is considered in a somewhat restricted sense. These are the tensile test and the fatigue test. No criticism is implied here of the many other forms of tests, such as impact tests, bend tests, hardness tests, etc. The purpose of the latter group of tests, however, is either to establish or confirm results that eventually must be derived from the tensile test, or to measure properties other than actual strength. We may regard the fundamental knowledge of the materials, accessible to the designer as the results obtained by applying a principal stress along the axis of a cylindrical bar. Practically everything else is derived knowledge.

The restricted range of the measurable properties of engineering materials has injected a

considerable amount of mechanical routine into the procedure of selecting working stresses. It is proposed, therefore, to group the available information on the subject of strength in the following tentative classification:

1. Types of materials
   a. brittle materials
   b. ductile materials
2. Operating temperature
   a. normal temperatures
   b. elevated temperatures
3. Mode of stress application
   a. steady stress
   b. variable (alternating) stress
   c. impact stress
4. Type of stress
   a. tension and compression
   b. pure shear
   c. combined stress

Practically every group of this classification can be made the subject of controversy, and none, except the last, can be defined except by arbitrary limits.

Additional Knowledge Needed

As yet the scheme of classification is inadequately fortified with reliable knowledge. Certain combinations, such as the case of impact stress, brittle materials under variable stress or elevated temperatures, and ductile materials

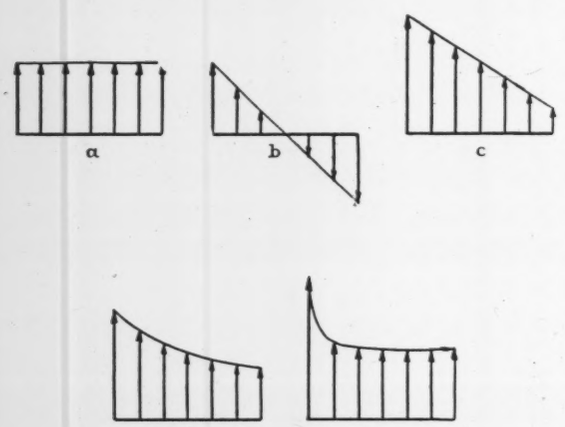


Fig. 2—Deviations occur when stress of tensile or compressive type varies in magnitude

under variable stress and elevated temperatures, are practically unknown, and until more knowledge is available, they must be kept out of discussions on working stresses. Practical applications, where necessary, must be made with extreme conservatism. The remaining parts of this paper will be devoted to a brief discussion of those combinations of materials at normal temperatures for which fairly adequate knowledge is available at the present time.

(a) Factor of Safety and Utilization of Strength

Let it be assumed that the failure of the element in question depends only on a certain stress σ, and that failure occurs when this stress reaches the limiting value σ_i. The working stress σ_w will then be defined by the relation

$$\sigma_w = u\sigma_i \quad \text{..... (1)}$$

where u is the factor of utilization. It is evident that $0<u<1$. The more common factor of safety is defined by $n = 1/u$. Failure is characterized by $u = n = 1$.

Can Interpret Experience

When rules for defining rationally the quanties σ_i and σ_w are achieved, the designer will be able to interpret his experience in a rational manner. The actual choice of margin between working stress and failure, the actual choice of margin between working stress and failure, the actual factor of safety, must remain the designer's own prerogative. The following may be stated with regard to the extreme limits of u: In the most favorable case of accurately known stresses and material properties, it should be possible to utilize 75 to 80 per cent of the strength of the materials, that is, $u = 0.7$ to 0.8. In the other extreme condition, such as may occur in cases of variable stress, it should not be necessary to go below $u = 0.25$ to 0.30.

(b) Ductile Materials Under Steady Stresses

The yield point in tension, as obtained from the ordinary tensile test, furnishes a unique definition of failure. The working stress may thus be expressed as

$$\sigma_w = u\sigma_y \quad \text{..... (2)}$$

where σ_y is the yield point. This conception enables the designer to effect an economical use of his materials whenever the conditions correspond to those of the tensile test. However, this is seldom the case, so that the above convention must be discussed in the light of the possible deviations from the ideal conditions of the tensile test.

Deviation Introduces Controversy

The first deviation of importance occurs when the stress is of the tensile or compressive type but varies in magnitude over the cross section, Fig. 2. This simple deviation from the test conditions opens an important field of controversy. The general question of combined stresses also enters into the controversy, but it is only in special cases that this aspect is of importance. It is by no means self-evident that the various cases shown in Fig. 2 should be covered by the same limiting stress, nor is such a conclusion supported by experiment.

All that can be said with certainty about

these cases is that when the stress variation is "sharp," Fig. 2 (*e*), only the mean stress has real influence upon failure. This condition is usually referred to as "stress concentration," which may thus be neglected in ductile materials under steady stress. In all the other cases the maximum stress must be considered in predicting failure. The actual importance of the maximum and the mean stress is associated with the external conditions of yielding, which must eventually determine whether it is a question of "sharp" or "moderate" variation of the stress over the section.

Other deviations of importance may be listed under the heading of combined stresses. This presents a more difficult and somewhat controversial extrapolation from the tensile test. When considering the purely practical aspects of the problem the simpler maximum-shear theory will cover the facts with sufficient accuracy. Un-

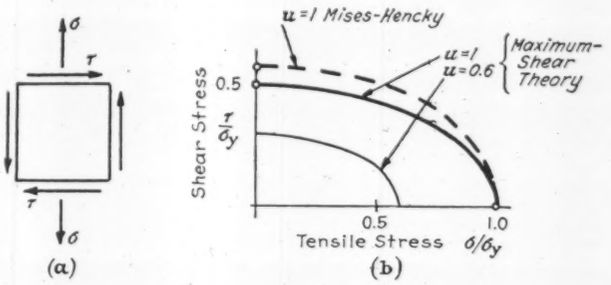


Fig. 3—One of most common combinations of tension and shear is the case of bending and torsion

der this interpretation, the failure is attributed to slip in the planes of maximum shear. In the ordinary tensile test the failure at the yield point is actually a shear failure in planes inclined 45 degrees to the axis of the specimen. The maximum shear stress is one-half the maximum tensile stress, so that for pure shear equation (2) is modified into

$$\tau_w = u\sigma_y/2 \quad \ldots\ldots (3)$$

with τ_w = working stress.

The same reasoning is extended easily into combinations of tension and shear, Fig. 3 (*a*), one of the most common of which is the case of bending and torsion. Instead of a single-valued working stress, there is now a case of superposition of one stress upon the other. The maximum-shear theory predicts failure for combinations falling on the ellipse $(\sigma/\sigma_y)^2 + 4(\tau/\sigma_y)^2 = 1$, Fig. 3 (*b*) where τ is the shear stress. The utilization of the portion u of this strength is represented by another ellipse, contracted in scale by the factor u. On this basis the working stresses are determined by the relation

$$\sqrt{\sigma_w^2 + 4\tau_w^2} = u\sigma_y \quad \ldots\ldots (4)$$

The results obtained from the tensile test generally are accepted as holding for compression as well. For practical purposes this is true for most of our ductile materials up to the point where structural instability becomes of importance. There is another form of compression, however, which presents a much more complicated phenomenon and also has real practical importance. This is the problem of contact

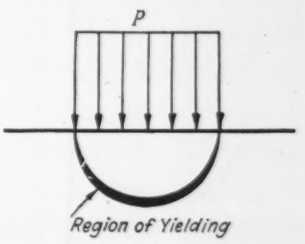


Fig. 4—Predicted yielding will occur along semicircle shown in case of uniform pressure

stresses between surfaces in machine parts. In the common case of uniform pressure along a strip of material, Fig. 4, the predicted yielding will occur along the semicircle shown. The value of the pressure at which yielding starts is $p = \pi/\sqrt{3}\sigma_y = 1.81\sigma_y$, ($p$ = external pressure) and is obtained by assuming that there are no friction forces on the contacting surfaces. In reality, this friction is of great importance, since it restricts the lateral contraction. For this reason, actual failure will not take place for pressures of the order of $2\sigma_y$, a value which is thus on the safe side for practical applications.

(*c*) *Ductile Materials Under Variable Stress*

For conditions similar to those prevailing in the conventional fatigue bending test, the endurance limit σ_e gives a unique definition of failure, so that the working stress may be expressed as

$$\sigma_w = u\sigma_e \quad \ldots\ldots (5)$$

The inaccuracies of extrapolation to other circumstances are in this case much greater than in the previous one.

Maximum Stress Dominates

The maximum stress now plays a much more dominating role even in the case of stress concentration. However, there is a tendency similar to that described for steady stress in that failure is precipitated by the maximum stress when the variation of stress is "moderate," and by a stress somewhat smaller than the maximum stress when the variation is "sharp." In general, the factors of stress concentration obtained by the theory of elasticity are about double those obtained by fatigue tests on grooved specimens of ductile materials. It is important to remember, nevertheless, that σ_w in (5) represents a stress in excess of the mean stress.

The difference in behavior of the ductile materials under steady and variable stress is associated with the different mechanisms of failure. The failure under variable stress is closer to the brittle type of failure under steady stress, and the two phenomena do indeed display certain

similarities. The case of combined stresses is accordingly somewhat complicated. The knowledge available so far indicates that the configuration of the failure may be interpreted in the light of the maximum-strength theory, but that the numerical value of the endurance limit in torsion comes close to one-half the endurance limit in bending; a relation that would point to the maximum-shear theory. Fig. 1 illustrates a typical failure under variable torsion stress, the 45-degree cracks pointing to failure in planes

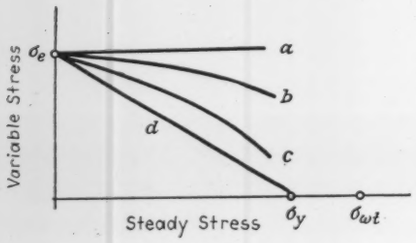


Fig. 5 — Many forms of superposition are indicated by the available results

of maximum stress. Until further information is available, it appears safe to predict failure on the basis of the maximum-shear theory. Whenever possible, an actual endurance test under the combined stress in question should be made.

Superposition May Occur

Another important phase of the subject concerns the problem of the simultaneous existence of steady and variable stresses. This is a case of superposition not unlike that of tensile and shearing stress. Given a material with the yield point σ_y and endurance limit σ_e, subjected to a steady stress σ_0 and a variable stress σ_r, what is the probable combination for failure? The available results indicate the existence of many forms of superposition, from practical lack of interdependence to actual linear superposition, Fig. 5. The reason for this absence of conclusive data may be ascribed to the fact that the ultimate strength is more closely related to the endurance limit than to the yield point. The linear form of superposition is particularly simple, however, and in general not far from the actual result in most materials. Under this assumption, failure under the simultaneous application of σ_0 and σ_r takes place for the combinations $(\sigma_0/\sigma_y) + (\sigma_r/\sigma_e) = 1$, so that an appropriate rule for the working stresses is developed as

$$\frac{\sigma_{0w}}{\sigma_y} + \frac{\sigma_{rw}}{\sigma_e} = u \qquad (6)$$

For materials that exhibit the laws of superposition given by the curve *b* or *c* in Fig. 5, this law may be changed to

$$\sqrt{\left(\frac{\sigma_{0w}}{\sigma_y}\right)^2 + \left(\frac{\sigma_{rw}}{\sigma_e}\right)^2} = u \qquad (6a)$$

but this modification may sometimes fall on the unsafe side of the experimental results.

The case of variable stress is important because of the remarkable influence of factors which do not commonly influence strength. The question of finish, ordinarily not of fundamental importance in strength problems, may assume real importance. Cases where unmachined specimens have shown 50 per cent lower strength than polished specimens of the same material have been recorded. This influence appears to be greater for alloy steels than for carbon steels. The phenomenon known as "corrosion fatigue" covers cases where apparently slight intensities of corrosion affect the endurance limit profoundly, even to the point of raising doubts as to its existence. There is not much doubt that this phenomenon is secondary to stress concentrations produced in the corrosion pits and possibly in intercrystalline cracks.

Variable Stress Important

The case of variable stress represents perhaps the most important and most difficult case in connection with working stress. It is a case, moreover, where standardized rules of convention can do more harm than elsewhere. It is therefore necessary to study one's own special cases particularly closely in this field. One of the most important sources of information on this subject arises through the configuration of the cracks.

(d) Brittle Materials

The conditions of failure for brittle materials under steady stress are similar to those for the ductile materials under variable stress, the ultimate strength σ_u being the limiting stress.

The effect of stress distribution is similar to that for the ductile materials under variable stress, and the rules just discussed for ductile materials under variable stress may be used for brittle materials under steady stress.

Properties Frequently Vary

The brittle materials frequently have fundamentally different properties for tension and compression; the ultimate strength in compression is often much greater than for tension. This is particularly the case for cast iron and represents one of the most important reasons for its successful application to many important stress problems. It is necessary, therefore, to deal with two values for the ultimate strength: the tension value σ_{ut} and the compression value σ_{uc}, the latter frequently being four to five times as great as the former.

Under combined stress, the brittle materials generally may be treated by the maximum-stress theory, but in reality the failure problem is much more complicated.

The behavior of the brittle materials under variable stress is a subject on which little is

known. It is to be expected that brittle materials will behave erratically under variable stress and be particularly sensitive to stress concentration. Results obtained for cast iron indicate that this suspicion is not always justified. It must be regarded as good design practice, however, to avoid variable stresses of appreciable magnitude in the brittle materials.

At elevated temperatures the problem of failure assumes a double aspect. On the one hand there remains the original problem of strength, modified and complicated by the many changes of internal structure of the materials that may occur. On the other hand there appears the question of preserving the physical dimensions and initial stresses during a certain part of the life of the structure. The former aspect must be treated by the same fundamentals as those given in the preceding sections of this paper, modified for the many possibilities of unorthodox behavior of the materials. (This latter subject is covered in greater detail in the original paper from which this article is abstracted).

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Build Sales Value into the Machine!

By J. F. Cavanagh

IN THESE days of industrial affliction when manufacturers are disposed to weigh departmental efficiency directly by results, a new approach is needed in the development of machinery. For many it will be like starting over again, yet they should realize that we have a more critical, more sophisticated buying group than ever before.

In the engineering departments certain basic considerations should be set up as guide posts. Regardless of talent available, not excepting inventive accomplishments, the dominating effort should be controlled by three considerations: sales value, cost and production adaptation.

Sales value must be built into the machine from its inception. To attempt to perfect a design without close co-operation with the sales department is simply hit-or-miss. At best it involves great risk. Inventive skill, design artistry and all other functions of a modern engineering department should be interpreted through salesman's eyes if the machine is to possess that indispensable characteristic, salability.

Cost is more strictly an engineering problem but it also may be disposed of best in close co-operation with the shop executives.

Production adaptation is a consideration of utmost importance and the designer should train himself to think in terms of production methods in order to avoid difficult machining operations and to permit low selling price.

That period immediately after the completion of research and the approval of hand-made samples is an extremely critical one. Up to this point the engineering department has been the sales department while the sales department has functioned as purchaser. The final step is to place the product in the hands of a critical public and breast competition.

Buyer's Reaction Is Important

If the manufacturer would but recognize this period as a distinct phase of development and treat it accordingly much trouble would be averted, but all too frequently he yields to the feeling that research is past, the item has been accepted and tests have been conclusive—nothing now remains but to rush the tooling for a large quota. But the buyer is yet to be heard from.

Regardless of how carefully the field may be studied, open contact with the market must await the start of production, and seldom does the new product become the square plug in the square hole. The first reaction however commendatory usually is accompanied by requests for modifications. Then one wishes his fore-

sight was as good as his hindsight. Just at this point is an opportunity for the exercise of that rare gift which the old timers call horse sense and here is the opportunity to save many dollars, often accompanied by a considerable saving in time in the matter of quota production.

Manufacturers of larger units, such as machine tools, perhaps are placed more favorably in these premises than the producer of small devices inasmuch as their manufacturing equipment possesses a flexibility and adaptability which enables them to complete a few machines without much special tooling. On the other hand, manufacturers of light machinery and devices which feature interchangeability are at the beginning of active production confronted with a tooling budget which ranges from $2000 in the case of a simple device, to perhaps $150,000 on a light mechanism of the order of a calculating machine.

Wide Background Required

High grade tooling calls for a background of wide experience linked with mechanical knowledge and ingenuity bordering upon the inventive. If such talent is directed for a short period toward considerations of low cost, expediency and speed in the production of a small advance quota, the resulting information will be three fold: First, the sales department will be enabled to place manufacturer's samples in critical fields, or in other words, put them through the clearing house. Second, the difficult or tricky parts may be circumvented. Third, the merits of untried manufacturing operations may be determined.

In providing tools for a small advance quota the engineer may choose between improvised tools, the cost of which is kept sufficiently low as to be absorbed or he may design certain high production tools which control the vital factors in interchangeability and carry their construction only to the point where samples may be struck. In most cases it will be found advisable to utilize improvised tools such as bending and forming blocks for use in a small hydraulic press and simple tools for the foot press. In many cases S. A. E. 1020, pack hardened, will be found satisfactory tool material for several hundred parts.

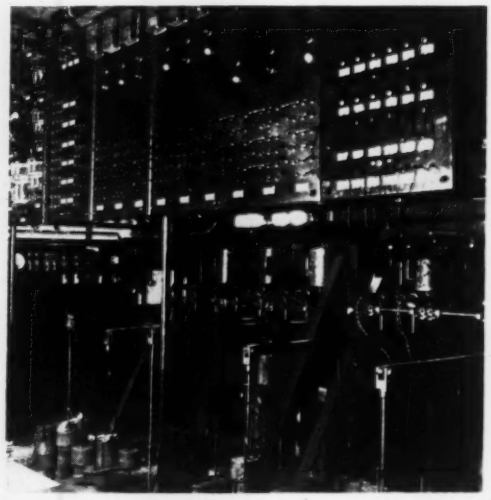
Should Employ Efficient Means

Manufacturers of light machinery or small devices who contemplate introducing new items should avail themselves of some of the time saving developments which the market lull has enabled others to perfect. By so doing they not only provide the most efficient means for producing their high production tools but of utmost importance at present, they will be in a position to handle expeditiously that very important phase of production, the initial quota.

Accurate Tests Required for Creep Determination

INVESTIGATION of the creep of metals at elevated temperatures is a complicated process requiring considerable scientific apparatus. Automatically held at exact temperatures in individual furnaces, various samples carry heavy loads for months, while sensitive instruments, shown in the accompanying illustration from Westinghouse laboratories, indicate minute changes. Curves are plotted and the alloys best suited for the job at hand then are selected.

While the creep test is the best known method of predicting the value of a material for high temperature service involving small permissible deformations, its limitations cannot be ignored. At best, the length of a creep test is small compared to the time during which a material is expected to give satisfactory service. Extrapolation of creep curves is necessary but great care is essential if large errors are to be avoided.



Section of apparatus used to measure creep in various metals at high temperatures

It is agreed generally that creep is affected by the previous history of the material, especially in the case of alloys which exhibit age-hardening tendencies. For example, a creep test may be completed in which the measured creep rate is negative because some structural change completely hides the creep. A more dangerous case is the one in which the creep is reduced to a small value during the test by age hardening. In this case the danger lies in the probability of an increased creep rate after the maximum age hardening effect is passed in service.

Neither the designer nor the testing engineer can extrapolate the creep curves with accuracy if the metal is such that internal changes are apt to take place during the test or in subsequent service.

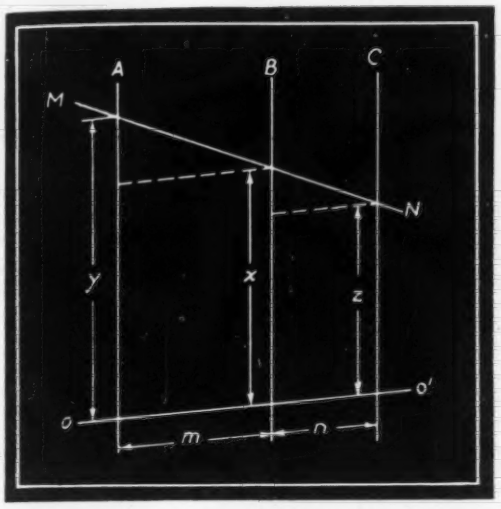


Fig. 1—Basic parallel scale diagram indicates relationship between spacing of axes

How to Construct Nomograms for Use in Design

By Eldon K. Ralston

NOMOGRAMS, in general, may be defined as graphical or diagrammatic representations of equations, and as such they provide a graphical method of solution of those equations. This method of solution possesses several distinct advantages which in many cases make the construction of a nomogram for the solution of an equation decidedly worthwhile.

Several of these advantages may be cited here. A diagram for an equation or formula which must be solved a large number of times often can be constructed easily, and as the graphical solution takes only a few seconds a large amount of design calculation may be eliminated. Furthermore, the graphical representation of such equations often will show the rate of variation of one variable with respect to any other variable in a manner which is not seen easily from the equation itself. The fact that with a nomogram any one variable of an equation may be solved for just as easily as any other is sometimes an advantage.

Results Within Usual Limits

As for the accuracy of this method of solution, it will be found from inspection of carefully constructed nomograms which are of sufficient size that the results will be within ordinary engineering limits of accuracy.

An alignment diagram is one on which the solution may be obtained (and hence the solution of the equation) by the use of one or more straight lines joining the various values of the different variables on their respective scales. Figs. 3 and 4 show diagrams of this type. On Fig. 3, which is the diagram for an equation of three variables, any straight line drawn across the three scales (such as the dotted line shown) will give a set of values of the three variables (T, S_s and d) which will be a solution of the equation for which the diagram was drawn. Thus d, which appears in the equation of this diagram as d^3, may be found just as easily as T.

This method of solution (the use of the straight line) lends itself to other types of diagrams such as the 'Z' and the 'Box' diagrams often found in engineering literature. However, the parallel scale alignment diagram, such as Figs. 3 and 4, is perhaps the simplest and most useful, for this type is best suited for equations which contain either the *sum* or the *product* of a number of terms. It is this type which will be discussed in this article. Inasmuch as the more complex diagrams of this type (i.e. those for equations of more than three variable as shown in Fig. 4) consist of several simple diagrams for three variables, one with three variables will be discussed first.

Before proceeding with the discussion of the general case, it will be necessary to define and illustrate two devices which are used to a great extent in the construction of nomograms, i.e. a *function scale* and a *scale factor*. An ordinary

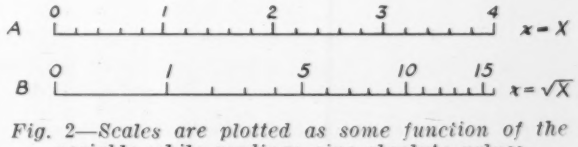


Fig. 2—Scales are plotted as some function of the variable while readings give absolute values

scale is one in which the distance measured along it is equal directly to the value of the variable marked on it. A function scale is one such that the distance measured along it is equal to *some function* of the variable marked on it.

As an example consider the construction of a

function scale for the square root of the variable X. If x is the distance along the scale from the origin to any point, the equation of this scale may be written:

$$x = f(X) = \sqrt{X}$$

Where f (X) is the function of X. Then on this scale the distance measured from the origin to any point is equal to the square root of the value

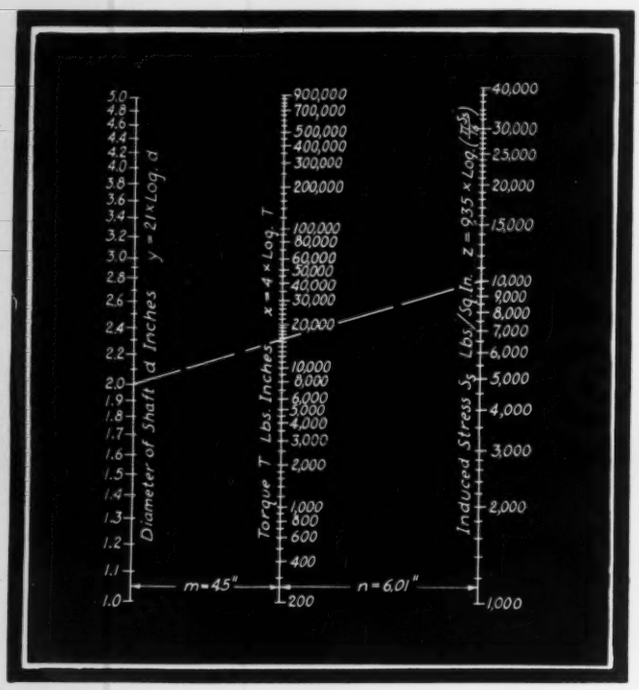


Fig. 3—A straight line drawn across scales gives any variable instantly when other two are known

of X marked at that point. On Fig. 2, A is an ordinary scale and B is the function scale for the square root of X. The logarithmic scale on a slide rule is a common example of a function scale.

Must Fit Scale to Space

In the construction of nomograms it often is necessary to increase or decrease the length of the original scale to fit it in the available space. This may be done by multiplying the original unit distance by a constant, called a scale factor, and thus change accordingly the total length of the scale. An engineer's scale is a good example of the use of a scale factor in deriving a new scale, for in this case all the other scales are obtained from the 1-inch scale by multiplying it by different scale factors (½, ¼ etc).

The problem of constructing a diagram for an equation of three variables resolves itself into one of finding the correct spacing of the scale axes, the correct location of the scales along their axes and the proper size of the scale units. Consider first the case of a parallel scale alignment diagram for an equation of three variables. Fig. 1 illustrates the fundamental dimensions of such a diagram. Assume that the three variables are plotted along the parallel lines A, B and C. The scale used for plotting each variable is determined by its function which is multiplied by the scale factor necessary to permit the variation desired to be included in the space provided. The line O-O' is the base line or axis and may or may not be perpendicular to A, B and C. The dimensions m and n measured along O-O' denote the spacing of the scales A and C from B. M-N is any straight line drawn so as to intercept points on the three scales, the ordinates of which are x, y and z.

Straight Line Solves Equation

It now is possible to determine the correct relationship between the scale factors and m and n so that any set of points on the three scales intercepted by a straight line will be a solution of the general equation :

$$f(X) = f(Y) + f(Z) \quad \ldots\ldots (1)$$

where $f(X)$, $f(Y)$ and $f(Z)$ are functions of the three variables X, Y and Z, respectively. From the definition of the scales it will be seen that the ordinate of any point, measured from the base line, will be equal to the function of the value of the variable at that point multiplied by the scale factor of that particular scale. Thus:

$$x = k_1 f(X),\ y = k_2 f(Y),\ z = k_3 f(Z) \quad \ldots\ldots (2)$$

where k_1, k_2 and k_3 are scale factors. On Fig. 1 the two triangles formed by the dotted lines are similar. Hence:

$$\frac{y-x}{x-z} = \frac{m}{n} \quad \ldots\ldots (3)$$

It can be proved that the ratio of m and n should be chosen so that

$$m/n = k_2/k_3 \quad \ldots\ldots (4)$$

then substituting this ratio and the values of x, y, and z as given by equation (2) and (3) we have:

$$\frac{k_2}{k_3} = \frac{k_2 \times f(Y) - k_1 \times f(X)}{k_1 \times f(X) - k_3 \times f(Z)} \quad \ldots\ldots (5)$$

or rewriting:

$$f(X)\ [k_1 k_2 + k_1 k_3] = k_2 k_3\ [f(Y) + f(Z)] \quad \ldots\ldots (6)$$

And substituting the value of $f(X)$ as given in equation (1) for $f(Y) + f(Z)$ we have:

$$f(X)\ [k_1 k_2 + k_1 k_3] = k_2 k_3 f(X) \quad \ldots\ldots (7)$$

And solving for k_1:

$$k_1 = \frac{k_2 k_3}{k_2 + k_3} \quad \ldots\ldots (8)$$

To summarize, an alignment diagram for the general equation $f(X) = f(Y) + f(Z)$ may be plotted by first determining the scale factors k_2 and k_3 so that the scales for $f(Y)$ and $f(Z)$ will include the desired range of these variables, and

then after the positions of the scales have been determined from the ratio m/n as found from equation (4), the function scales $y = k_2 \times f(Y)$ and $z = k_3 \times f(Z)$ may be plotted. Then from equation (8) k_1 can be found and the function scale $x = k_1 \times f(X)$ may be plotted.

It was stated previously that this type of diagram is best suited for equations which contain either the product or the sum of several terms, each a function of an independent variable. In case the equation contains the product of several terms it simply is necessary to take logarithms of both sides of the equation, thus reducing the equation to the sum of the logarithms of the various terms. Should there be a variable in both numerator and denominator, first clear of fractions.

As an example consider the construction of a diagram for the equation:

$$T = \frac{\pi d^3}{16} S_s$$

Where T is the torque transmitted by a shaft with a diameter d and in which a maximum shearing stress S_s is induced. Inasmuch as this equation contains the product of the variables, it will be necessary to take logarithms to obtain the form of the general equation, which reduces the equation to:

$$\log T = 3 \log d + \log (\pi S_s/16)$$

The functions of the three variables then may be written:

$$f(X) = \log T, f(Y) = 3 \log d, f(Z) = \log (\pi S_s/16)$$

thus satisfying equation (1). Assume that this diagram be plotted so that the length of the scales is approximately 15 inches and that the range of the variables is as follows: d is to vary from 1 to 5 inches; S_s from 1000 to 40,000 pounds per square inch. The torque T will vary accordingly, but it is not necessary to consider this variation at this point for it is taken care of automatically in the construction of the diagram. Limits of variance are taken from the first practical value and not from zero. The scale factor k_2 may be found in the following manner. The total variation in $f(Y)$ is:

$$3 \log 5 - 3 \log 1 = 2.084$$

Then to make this scale 15 inches long:

$$k_2 = 15/2.084 = 7.2; \text{ or say } k_2 = 7.00$$

In the same manner the total variation in $f(Z)$ is found to be 1.602 and thus $k_3 = 9.36$, or say 9.35 for convenience. This small change in the scale factors from the computed values simply means that these two scales will not be exactly 15 inches long. Then from equation (8), k_1 is found to be 4.00 and from (4) the ratio m/n is found to be 7.00/9.35. If m is chosen as 4.50 inches, then $n = 6.01$ inches. Fig. 3 shows the method of plotting this diagram. The axes of the three scales are located from the values of m and n as found. Then on the axis to the left, the function scale, $y = 21 \log d$, is plotted and on the axis to the right the function scale, $z = 9.35 \log (\pi S_s/16)$, is plotted. The final step is to plot the middle scale for $x = 4 \log T$. It is necessary, however, to determine first the correct location of this scale along its axis.

This is accomplished in the following manner: Take a particular value of each of the two variables the scales of which have been plotted—say $S_s = 10{,}000$ pounds per square inch and $d = 2$ inches. From the equation the corresponding value of the torque can be calculated, i.e. $T = 15{,}730$. Then a line joining $S_s = 10{,}000$ and $d = 2$, on the diagram (shown dotted) must intersect the torque scale at $T = 15{,}730$ and the scale may be adjusted along its axis to fulfill this condition. It should be noted that it is seldom necessary to construct a function scale such as those shown in the accompanying diagrams by

(*Continued on Page* 58)

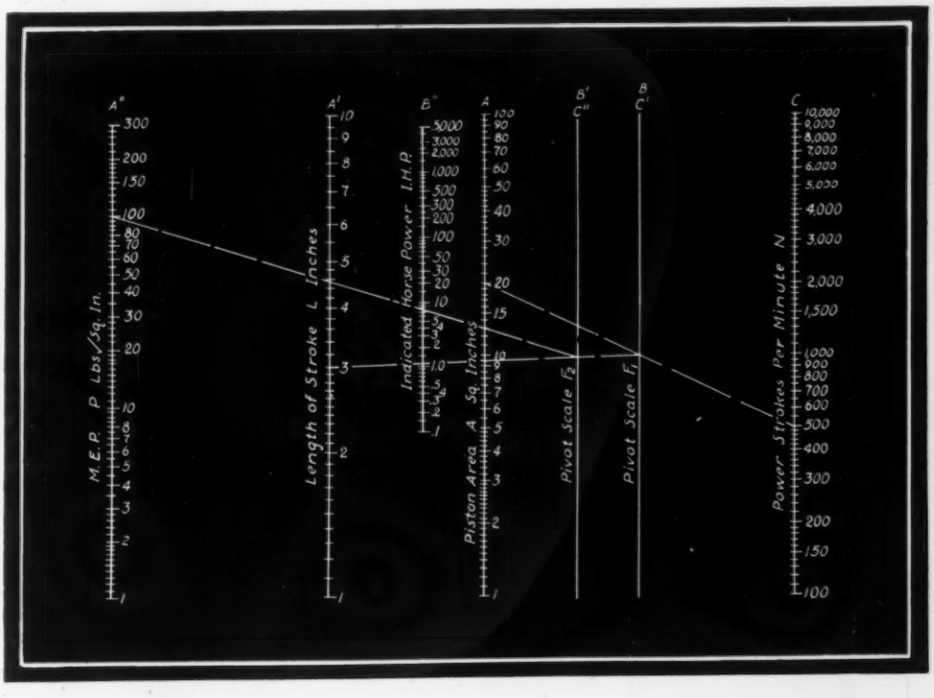

M.E.P. P Lbs./Sq. In.
Length of Stroke L Inches
Indicated Horse Power I.H.P.
Piston Area A Sq. Inches
Pivot Scale F2
Pivot Scale F1
Power Strokes Per Minute N

Fig. 4—Equation with more than three variables may be plotted by breaking it down into several equations with three variables each

Editorial

Ideal Design Considers Both Existing and Future Conditions

IN THE face of the present unsettled state of business, many manufacturers are puzzled as to what policy should be pursued in connection with the introduction of new machines or improved models. Motor car builders and others dealing direct with consumers believe that new designs, introduced now, will stimulate purchasing. On the other hand, many manufacturers of equipment and parts for industry hesitate to bring out radically improved products because they do not want to waste a good idea in an inactive market.

No general rule for this problem can be laid down; every case must be decided on its own merits. Moreover, the ability of a company to take proper action in introducing new machines depends in important degree upon its design policy.

Many companies, like individuals, are opportunists. They have no continuing program of development. When a good idea crops up, they capitalize on it promptly and wait for the next break. In the other extreme are companies which pursue a policy of methodical development in design. They usually have a number of new models or improvements in reserve. Their plans always are projected a few years into the future.

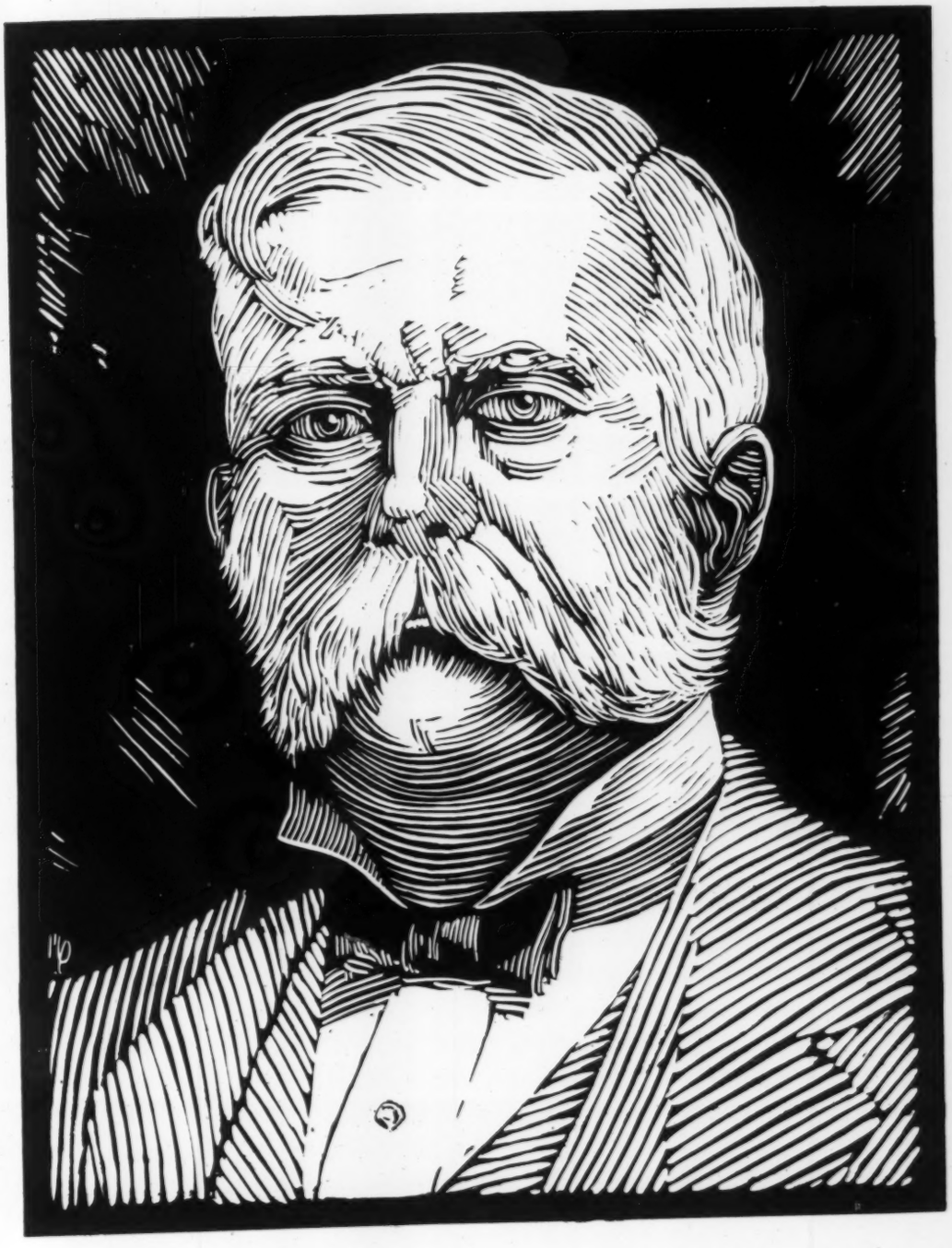
Of these two policies, the latter undoubtedly is the better. The opportunist manufacturer frequently gains a temporary advantage in his ability to act quickly, but in the long run the company with a foresighted policy of systematic development wins out because of its reservoir of available tested ideas.

In this or any other period, the ideal policy of design is one that provides for future planning but at the same time is flexible enough to permit prompt action in meeting a competitive situation or in capitalizing unforeseen opportunities.

Metal as a Selling Point

ALUMINUM, magnesium, nickel chrome steel, each has passed through a stage during which its use as a design material was prohibitive on account of cost. Yet each in turn has passed the barrier. Increased use has brought lower prices until today the choice of these materials has become much more a case of straight mechanical adaptation.

Will the same thing apply to beryllium copper? Characteristics of the new alloy augur well for its wide application. But the price is high. Engineers will recognize, however, that apart from the mechanical advantage of using a material of such unusual properties there is a sales value attached to its application in their machines which, if not abused, will amply repay its selection.



George Westinghouse

Master Designers

George Westinghouse

RAILROAD development in the United States is so much a part of the industrial growth of the country that it is impossible to conceive how manufacturing advances could have taken place without this important arm of transportation. At the time when railroad expansion was proceeding at its most rapid rate George Westinghouse introduced his air brake, and to him is due the credit for the ability of the railroads to employ longer, faster, more frequent trains. One-quarter of his more than 400 patents are concerned with brake development and include various types, automatic systems and the valves that made the devices practical.

THERE is an additional debt that the railroads owe Westinghouse, inasmuch as he developed the drawbar and couplings without which shorter trains would be a necessity, and the interlocking pneumatic signalling system. This man who had the perception and reflection so necessary to invention was born in Central Bridge, N. Y., in 1846 and received his first patent on a rotary steam engine at the age of 19. That early engine was always in his mind and it suggested some of the innovations Westinghouse later proposed for steam turbines.

THIS great mechanician received, co-ordinated and executed ideas, and a great many electrical developments are based on his suggestions. Proceeding with his usual energy and boldness, Westinghouse advanced the manufacture of power by the development of the use of alternating current in the distribution and application of power by electricity. Meters, rotary converters, lamps and induction motors were developed under his direction.

OTHER developments on which Westinghouse obtained patents include fluid pressure motors, telephone exchanges, improvements to steam engines, gearing, automobile air springs, water meters and slide valves. He was respected, admired and beloved by all who knew him and his death at the age of 68 was mourned by his workmen and by engineers the world over.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Welcomes Letters or Solutions to Problems Suitable for Publication

Designing Springs for Small Space

To the Editor:

IN NUMEROUS instances the writer has wanted a spring to take extremely heavy loads with little deflection, and at other times a spring to take moderately heavy loads with appreciable deflection. This requirement has been encountered in heavy hydraulic machinery, and without doubt other uses may be found such as freight car springs, locomotive springs, machinery suspensions to neutralize vibrations, and other places where there is not sufficient room for the usual helical type spring in the required capacity.

Considerable study led to the use of a ring type of spring, shown in the accompanying illustration, with the load applied at diametrically opposite points; a device that can be machined easily in a simple lathe operation. The lugs can be welded on after the other work is completed and then the final heat treatment made. Consideration was given to the fact that the spring suspension had to be capable of taking side forces normal to the axis of the lugs.

The stress and deflection analysis is given briefly for the benefit of those who may have use for this type of spring. It should be noted that the deflections can safely be larger than might be expected. The ring can be made relatively wide and thin or thick and narrow, giving a wide range in characteristics.

It is assumed that the problem is statically determinate; that only normal stresses will exist at sections as X - X; and that the load W will be divided equally over the two sides. In addition, it is assumed that X - X will remain normal to the direction of load, W, after loading.

By the principle of least work

$$dU/dM_o = 0 \quad \ldots\ldots (1)$$

At any section Z - Z, the bending moment is

$$M = M_o - \tfrac{1}{2}\, WR\,(1 - \cos\alpha) \quad \ldots\ldots (2)$$

The effects of longitudinal and shear forces can be neglected, so

$$U = \frac{1}{EI}\int_0^{\pi/2} \tfrac{1}{2}\, M^2 R\, d\alpha \quad \ldots\ldots (3)$$

Substituting (3) in (1)

$$\frac{dU}{dM_o} = \frac{1}{EI}\int_0^{\pi/2} [M_o - \tfrac{1}{2}\, WR\,(1 - \cos\alpha)]\, R\, d\alpha = 0 \quad (4)$$

resulting in

$$M_o = \tfrac{1}{2}\, WR\,(1 - 2/\pi) - 0.182\, WR \quad \ldots\ldots (5)$$

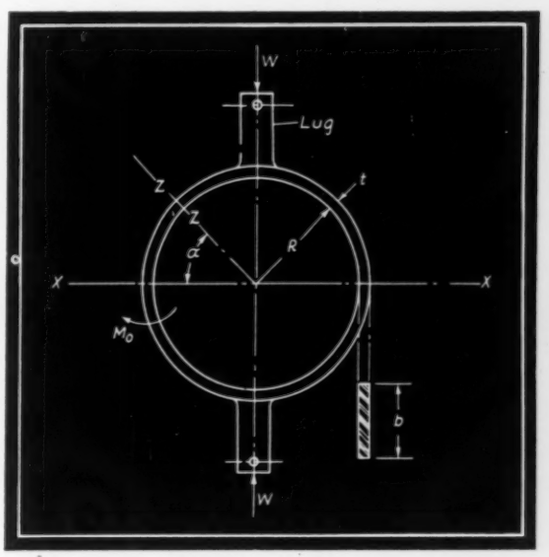
Substituting (5) in (2),

$$M = \tfrac{1}{2}\, WR\,(\cos\alpha - 2/\pi) \quad \ldots\ldots (6)$$

It is found that maximum bending moments exist at the points of loading. These values are, since α is then $\tfrac{1}{2}\,\pi$,

$$M = -\, WR/\pi = -\, 0.318\, WR \quad \ldots\ldots (7)$$

The deformation, or deflection, in the direction



Ring type spring takes extremely heavy loads with little deflection and occupies small space

of loading can be found from the potential energy of deformation as

$$U = \frac{2R}{EI}\int_0^{\pi/2} M^2 d\alpha \quad \ldots\ldots (8)$$

giving as the deflection

$$D = \frac{dU}{dW} = \frac{4R}{EI}\int_0^{\pi/2} M\,\frac{dM}{dW}\, d\alpha \quad \ldots\ldots (9)$$

and

$$D = \frac{4R}{EI}\int_0^{\pi/2} \tfrac{1}{2}\, WR \times \tfrac{1}{2}\, R\,(\cos\alpha - 2/\pi)\, d\alpha \ldots\ldots (10)$$

Reducing finally to

$$D = \left(\frac{\pi}{4} - \frac{2}{\pi}\right)\frac{WR^3}{EI} = 0.149\,\frac{WR^3}{EI} \quad \text{..... (11)}$$

with a rectangular ring section the moment of inertia $I = bt^3/12$ and E is found to be 29,000,000 in almost all steels. To find the maximum fiber stress, divide the maximum bending moment as found by (7) by the section modulus, which equals $bt^2/6$.

When considering stresses to be allowed, the nature of the load and its relative activity are to be considered with regard to fatigue. With some of the chrome-vanadium steels, properly heat treated, stresses as high as 160,000 pounds square inch can be used where the loading is fairly quiescent.

When the diameter of the lugs becomes large in proportion to the width of ring b and the thickness t, both the stress and the deflection are reduced below the formula values. This is to be expected since the lugs have an appreciable stiffening effect under such conditions.

—JOHN S. CARPENTER,
York, Pa

Care Required in Crossed Belt Design

To the Editor:

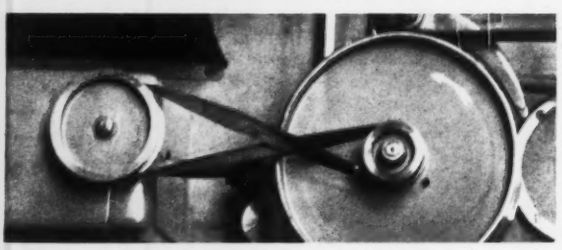
MAY I offer for the consideration of machine designers a formula pertaining to crossed belt drives which I developed recently? This formula includes all of the important factors in the problem, some of which were omitted by previous computations. It is

$$C = 2\,(D + d)\,\sqrt[3]{W}$$

where

C = distance between pulley centers, inches
D = diameter of driving pulley, inches
d = diameter of follower pulley, inches
W = width of belt, inches

This formula should not be applied to belts more than 8 inches in width or to pulleys larger than 40-inches diameter. It is preferable to use two-ply high grade belts on drives of this type wherever practicable. Single-ply belts that are well made are subject to the same formula as above, but as a rule single-ply belts are more erratic on crossed drives than are two-ply owing to the uneven stretch that so commonly occurs.



When belt twist is too abrupt there will be considerable rubbing and resultant wear at point of crossing

Occasionally we see shafts carrying crossed belt drives closer together than twice the sum of the pulley diameters, as for instance in the illustration herewith. For belts of one-inch width that center distance is exactly right, as it checks with the formulas. The shafts in this photograph are too close because the belt is wider than one inch, but on account of varying design conditions we cannot always have what is best, hence flanged pulleys are employed. It is understood in relation to this installation that belt wear will be somewhat greater than would be obtained with a correct center distance. Obviously, when the belt twist is too abrupt there will be considerable rubbing and resultant wear at the point of crossing.

—W. F. SCHAPHORST,
Newark, N. J.

Roller Clutches Gain Popularity

To the Editor:

WITH the advance in the employment of free wheeling clutches, radical change is noticeable in the design of ratchet wheels. Numerous types of machines that employ ratchets are substituting "ball clamp units" or mechanisms similar to those responsible for free wheeling and the advantages in their favor are numerous.

In the first place there is a constant demand for quietness in machinery, whether it be automobiles or the most crude farm equipment, and this new type of ratchet mechanism is entirely noiseless.

The cost of manufacturing the new type is comparatively low because most "ball clamp units" require but one milling operation, and where the use is not too severe, case hardening is often sufficient.

A unit of this type often is used to permit shafts to turn in one direction only or to prevent heavy machinery from reversing. Instead of the clutch having to arrest the back motion before it can run a machine forward, as in the case of presses or heavy drops, it has only to start them up from a dead motion.

Whether units of this type were used before free wheeling was introduced I cannot say, but the trend at present seems logically in their favor.

—LLOYD A. WHITTAKER,
North Attleboro, Mass.

Editor's Note—A more complete consideration of this subject is included in MACHINE DESIGN articles as follows: "Roller Friction Clutch Is Simple and Accurate," May, 1931, pp. 48, 49; "Solenoid Operation Features Design of Office Appliance," December, 1931, pp. 17, 18; and "Developing the Overrunning Clutch," July, 1932, pp. 24, 25, 28.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

New Institute Formed to Supplant N. E. L. A.

ANNOUNCEMENT has been issued that the National Electric Light association, which comprises 85 per cent of the electric light and power industry of the United States, has been dissolved and in its place the Edison Electric institute has been formed. Floyd L. Carlisle, chairman of the board of the Niagara Hudson Power Corp., and Consolidated Gas Corp., who will act as a director of the institute, said: "Those of us having to do with the organization of the institute felt that the National Electric Light association, as such, should be dissolved rather than remodeled. Rightfully or wrongfully, it had the reputation of a great propaganda organization and it seemed the part of wisdom to end it and start afresh."

* * *

Mark Is Set In Handling Patents

ENGINEERS will be interested in the dispatch with which the patent office now is able to handle patents. For the first time in history, the department passed the 100,000 mark in its disposal of patent applications during its past fiscal year. In fact the total disposals reached 100,960, a gain of 7553 over the previous peak reached in the fiscal year of 1931. The new record was set in catching up on work in arrears since the actual number of new applications fell off from the 1931 figure, or from 84,097 to 73,465. However, the number of amendments received to old applications increased by 15,285.

* * *

Japanese Bulb Imports Hurt Home Industry

MARKETING of Japanese electric light bulbs in this country has caused wide comment by industrialists. Typical are the remarks of Arthur E. Allen, vice president of Westinghouse Lamp Co. At an Electrical League meeting late last year he pointed out that the American people will pay $12,000,000 more during the year for electric light bulbs because they are imported Japanese units. It costs the Japanese fifty-eight hundredths of a cent to make a Christmas lamp, while the material for this same bulb costs the American manufacturer eight-tenths of a cent.

Further data presented by Mr. Allen disclosed that the Japanese make complete flashlight lamps for four-tenths of a cent while the material for this product costs the American manufacturer six-tenths of a cent. A 60-watt Japanese lamp, bulb manufacturers claim, can be landed in New York City for two and one-eighth cents while the material costs the American producers two and six-tenths cents. All this goes on in spite of a 20 per cent tariff, Mr. Allen said, and because of these conditions 2000 American workmen have been thrown out of jobs and $2,500,000 lost in wages. Could anything be more indicative of the need for constant improvement in design of domestic machinery?

* * *

Testing Association for Britain Proposed

ONE topic of timely interest concerns efforts in Great Britain to set up a national testing association to determine the quality of materials intended to comply with specifications of the British Standards institution. This movement is to be instituted by industry itself and the functions will be supplementary to those of BSI. Under the present British regulations makers of materials and manufacturers are granted on request permission to put the BSI mark on their products if the institution has approved the means employed for examination and test, either in the manufacturer's plant or elsewhere. The latest proposal goes further in that it is intended that certification by an independent body is to be used as an added endorsement to the claims of manufacturers.

* * *

Welding Patents Are Upheld

AFTER litigation extending over eight years, in which the Johnston patents covering electric resistance welding of tubing and pipe, owned by Steel & Tubes Inc., Cleveland, have been upheld uniformly, the United States Supreme Court has refused to review the favorable outcome in the court of appeals. Steel & Tubes is a subsidiary of Republic Steel Corp., Youngstown, O., where the Johnston process, originally developed to produce small, light wall mechanical tubing, has been applied to commercial production of pipe in sizes up to 16 inches in diameter and in all standard wall thicknesses.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

ENGINEERING research has been zealously sponsored by Dr. Charles Russ Richards, president of Lehigh university . . . in fact he is one of its outstanding exponents. His broad experience in conducting and directing this type of work will be a distinct asset in carrying out his duties as a member of the main research committee of the American Society of Mechanical Engineers, to which post he recently was appointed by President A. A. Potter.

Previous to Dr. Richards' installation as president of Lehigh university in 1922, he was dean of the college of engineering and director of the engineering experiment station at the University of Illinois. Throughout his entire career he has contributed largely to the physical expansion of engineering colleges, having designed and erected shops and mechanical laboratories at the Universities of Nebraska and Illinois and the Colorado Agricultural college. He also was dean of the college of engineering at the University of Nebraska.

Service to the American Society of Mechanical Engineers through committee membership is no new experience to Dr. Richards; aside from his regular term as manager from 1918 to 1921, he has served on the committee on local sections, the executive committee of the fuels division, and retained his membership on the power test code committee on fuels. In addition to these he was the A. S. M. E. representative on the joint committee on engineering education. This veteran engineer was elected to membership in the society in 1892.

RAPID growth and improvement of the oxy-acetylene process used widely in welding and cutting machine parts, has materialized during the period in which E. J. Hayden has been associated with Linde Air Products Co., New York. His broad experience gained through 18 years in the industry will be of inestimable value to him in his new office as president of the International Acetylene association. At the present time he is located in Chicago as manager of the central division of the Linde company.

Most of Mr. Hayden's industrial career has been spent in the East. He was born in Brooklyn, New York, Jan. 24, 1890, and received his grade school and higher education there. In 1914 he joined his present organization, his work in the sales department leading later to an appointment as eastern division manager. A transfer to Chicago came in 1924. Mr. Hayden has been active in the affairs of the International Acetylene association for some time, having served as vice president of the body during the past year.

ENGINEERS now are finding a very definite place in the managerial side of industry, exemplary of which is the recent election of Frederick G. Hughes as vice president and general manager of the New Departure Mfg. Co., Bristol, Conn. Prior to his affiliation with this company in April, 1911, he was an experimental engineer with Bethlehem Steel Corp. and later chief engineer of Driggs-Seabury Corp.

Commencing with New Departure as production manager Mr. Hughes has risen rapidly to become chief engineer, assistant general manager and vice president. With the class of 1900 he was graduated from Yale university where he was a member of Sigma Xi. During the World war Mr. Hughes was an advisory engineer to the quartermaster department and a member of the war service committee on bearings.

In addition to his work with his present organization he has been active in the solution of many engineering problems of allied branches of the industry. As chairman of the standardization committee on ball bearings of the Society of Automotive Engineers, Mr. Hughes was instrumental in effecting much of the standardization now essential in automobile production. He also served as president of the American Society for Steel Treating and is a member of the American Society of Mechanical Engineers. Many noteworthy inventions in relation to ordnance, automobiles and roller and ball bearings are credited to him.

IMBUED with early pioneering in electrical engineering and trained throughout its subsequent development, is Dr. John Boswell Whitehead, professor of electrical engineering and

Leaders in Design, Engineering and Research

C. R. Richards

E. J. Hayden

F. G. Hughes

J. B. Whitehead

dean of the faculty of engineering at Johns Hopkins university, is a leader in his field. Just recently he was honored with nomination as president of the American Institute of Electrical Engineers, in which role this accumulation of knowledge and experience will work a significant benefit to the organization.

Born in Norfolk, Va., August, 1872, Dr. Whitehead entered Johns Hopkins in 1889, studying electrical engineering in these its earliest days under Duncan and Rowland, and obtaining his first degree in 1893, subsequently taking the degrees of bachelor of arts in 1898 and doctor of philosophy in 1902. When he left the university in 1893 he joined Westinghouse Electric & Mfg. Co., passing one year in the shops and two years in experimental development and design of transformers, his immediate superior being Charles F. Scott.

In 1896 he went to Niagara Falls with the first generators of the Niagara Falls Power Co. and passed a year with that company in the intitial stages of the operation of their plant. After returning in 1898 to Johns Hopkins for graduate work he became in 1902 research assistant in the United States bureau of standards, and from 1902 to 1905 research assistant of the Carnegie Institution, Washington, working in the laboratories of Johns Hopkins. He was appointed associate professor in electrical engineering at Johns Hopkins in 1904, becoming professor in 1910, and dean of the school of engineering in 1919. While Dr. Whitehead's chief association has been with education and research, he also has engaged actively in practice as consulting engineer.

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William L. Batt, president of SKF Industries Inc., New York, and John V. N. Dorr, president of the Dorr Co., New York, have been appointed advisory members of the council meeting of the college of engineering, New York university.

* * *

Howard Coonley, president Walworth Co., New York, has been elected president of the American Standards association for 1933. He succeeds Bancroft Gherardi, vice president, American Telephone & Telegraph Co. (M. D., Jan.)

* * *

R. P. Davis has been appointed dean of the college of engineering at West Virginia university to succeed C. R. Jones who becomes dean emeritus.

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Richard A. North, graduate of Yale, for six years on its teaching staff and since 1927 identified with the United States Shipping board and with the Grace Lines Inc., has been appointed assistant chief engineer of the Farrel-Birmingham Co. Inc., Ansonia, Conn. In his recent connection with the Grace Lines he has been technical director to the vice president in charge of operations.

* * *

A. A. MacCubbin, formerly chief engineer of the Barrett Co., New York, has joined the Executive Engineers Inc. as vice president.

* * *

Walter M. Hartung has been appointed dean of aviation at Beckley college, Harrisburg, Pa. He formerly was an aeronautic engineer with Granville Bros. Aircraft Inc., Springfield, Mass.

* * *

Charles S. Dahlquist recently was made executive engineer in charge of rubber tire railcar development at the Edward G. Budd Mfg. Co., Philadelphia.

* * *

H. S. Vassar, laboratory engineer of the Public Service Electric & Gas Co., Newark, N. J., recently was made a member of the executive committee of The American Society for Testing Materials. He has been associated with his present concern since 1903.

* * *

J. C. Henderson, for 17 years with Driver Harris Co., has resigned to devote his attention to a new development. In 1915 Mr. Henderson obtained what are said to be the first patents on heat resisting castings, particularly those of the nickel-chromium iron group.

* * *

Col. Hugh L. Cooper, chief consulting engineer on the Dnieprostroy hydroelectric project in Russia, has been awarded the Order of the Red Star, one of the highest decorations bestowed by the Soviet Government. Six members of his staff received the Order of Lenin at the same time.

* * *

Robert P. F. Liddell, who resigned recently as chief engineer of Motor Improvement Inc., Chicago, now is assistant to the chairman of Hat Corp. of America, New York.

* * *

Lewis Deesz, formerly testing engineer for the Colorado Fuel & Iron Co., Denver and Pueblo, Colo., and since January, 1931, doing engineering work in Russia in connection with metallurgical projects, has been awarded the honor of Udarnich, or the "Lenin Star," by the U. S. S. R.

William G. Newton has established offices in New Haven, Conn., where he will head a staff of consulting engineers, specializing in die casting and die casting equipment. Until recently he was president of Newton Die Casting Corp., New York.

* * *

John T. Stearn, for the past two years with the Toledo Synthetic Products Inc., has rejoined the investigatory staff of Mellon Institute of Industrial Research, where he will head the industrial fellowship sustained by the Toledo company.

* * *

Aldus C. Higgins has been elected president and general manager of the Norton Co., Worcester, Mass., succeeding Charles L. Allen, who has become chairman of the board.

* * *

Col. Charles H. March has been elected chairman of the Federal Trade Commission, Washington.

* * *

L. W. Ryan, formerly with the Titanium Pigment Co., is now director of research, United Color and Pigment Co., Newark, N. J.

* * *

J. E. Culliney recently was elected engineering vice president of National Safety council, Chicago.

* * *

A. W. Oakley, Merchants Refrigerating Co., New York, recently was made president of the American Society of Refrigerating Engineers. Louis S. Morse, chief engineer, York Ice Machinery Corp., York, Pa., and Frank R. Zumbro, Frick Co., Waynesboro, Pa., were appointed new directors of the society, while J. B. Churchill, consulting engineering, New York, and Crosby Field, Flakice Corp., Brooklyn, were re-elected directors.

Obituaries

EDWIN M. HERR, 72, who rose from messenger boy to head of one of the largest industries in the country, died recently in New York. At the time of his death, he was vice chairman of the board of directors of the Westinghouse Electric & Mfg. Co., a director of the American Manufacturers Export association, the Radio Corp. of America, Westinghouse Airbrake Co., and many other organizations.

Mr. Herr was born in Lancaster, Pa., May 3, 1860, and entered Sheffield Scientific school of Yale university in 1881. Graduating in 1884, he later became a mechanical draftsman for the Chicago, Burlington & Quincy railroad at Aurora, Ill., then engineer of tests, superintendent of telegraph and finally division superintendent. From 1893 to 1894 he was general superintendent of the Grant Locomotive Works, Chicago, subsequently becoming general manager of the Gibbs Electric Co., Milwaukee. George Westinghouse asked him to accept the position of general manager of the Westinghouse Air Brake Co. in 1898.

In 1905 Mr. Herr was elected vice president of the Westinghouse Electric & Mfg. Co., served as one of the receivers of the company, and upon its reorganization a year later, resumed his old position. He was made president in 1911. Yale university and Franklin and Marshall college conferred honorary degrees upon him, and in 1920 he was decorated by the Emperor of Japan with the Order of the Rising Sun.

* * *

John J. Hartley, western division chief engineer, Link-Belt Co., Chicago, succumbed to death on December 31, at the age of 39, the innocent victim of an assassin's bullets. He had been connected with the company's Pershing road plant in Chicago for the past 23 years, having started in the drafting room as a boy. Following a liberal experience in both the engineering and construction departments, Mr. Hartley also served the company in the capacity of sales engineer, and in 1929 was promoted to the position of chief engineer of its western division. His success was due largely to his genial disposition and ambitious nature. He engaged in much night study work to offset the lack of early schooling.

* * *

Kate Gleason, first woman member of the American Society of Mechanical Engineers, and an authority on gearing, died recently at the age of 67 in Rochester, N. Y. Older engineers will remember her as a sales representative of her father's company. Miss Gleason at the age of 11 began to study gear problems and early expressed a desire to become a mechanical engineer.

Completing a year in the mechanical engineering school at Cornell university, she left to travel for the Gleason organization in the United States and abroad. Later she became secretary and treasurer of the company. She was the first woman president of a bank, first woman to be appointed a receiver in bankruptcy and first woman member of the Verein Deutscher Ingenieure. More recently she became interested in low cost housing and was instrumental in creating a model community of 100 houses of standardized design erected by unskilled labor. Her own home was patterned after the famous Alhambra.

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

WIDER latitude in the design of templets for cutting difficult shapes by the torch is afforded by an improved electromagnetic templet follower embodied in the machine recently patented by James L. Anderson for Air Reduction Co., New York. Universal movement of the torch over the work is provided. A templet follower is used in which the magnetizing coil does not rotate with the follower located at the end of the coil remote from the support.

As shown in Figs. 1 and 2, a cam or templet 48 is passed beneath base 1 and raised so that post 3 passes through a hole in the templet. Arms 7 and 12 are hinged to double arm 6 by the two shafts 17 and 18 carried in the double arm 6 by bearings 19, 20, 21 and 22. Shafts 17 and 18 are pinned to arms 7 and 12 so that any rotation of the shafts rotates the arms. At the top of the shafts are pinned pulleys 23 and 24 which are connected together by a metal band or belt 25. This metal belt transmits the motion of one pulley to the other. To prevent the belt from slipping two pins 26 and 27 are driven through the belt into the pulleys in such a way that the pulleys are allowed to rotate about 175 degrees.

Metal to be cut is placed in position beneath torch 8. Templet follower 16 is brought into position at the starting point on the templets and made to adhere to it by energizing magnet coil 55 through switch 10. Rotation of follower 16 through motor 13 is controlled by switch 11 when the cutting operation has been started.

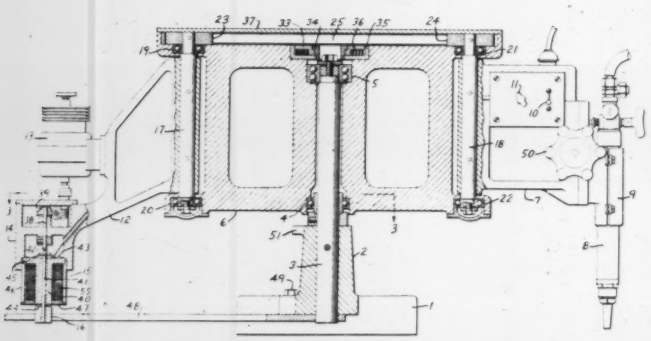


Fig. 1—Gas cutting machine embodies electromagnetic tracer mechanism

It will be observed that in this machine the electromagnetic templets follower is removed from the heat of the cutting operation; also that when the arms are folded the working space is cleared so that heavy pieces of work can be brought up and deposited by a crane in position for cutting. To counteract any unequal expansion or contraction between the double arm 6 and the belt 25, wear in the bearings or other cause for the development of slack, a belt tightening device is provided. This consists of two rollers 31 and 32 mounted on disk 33 which rotates freely in a cup made up of parts 34 and 35. Cup 35 is fixed solidly in a recess bored in double arm 6. One end of the coil spring 36 in fastened to disk 33 and the other end is fastened to cup 35. This coil spring is under tension at all times, tending to rotate disk 33 with its rollers 31 and 32 around part 34, thus maintaining an even tension on belt 25. The patent is identified as No. 1,891,880.

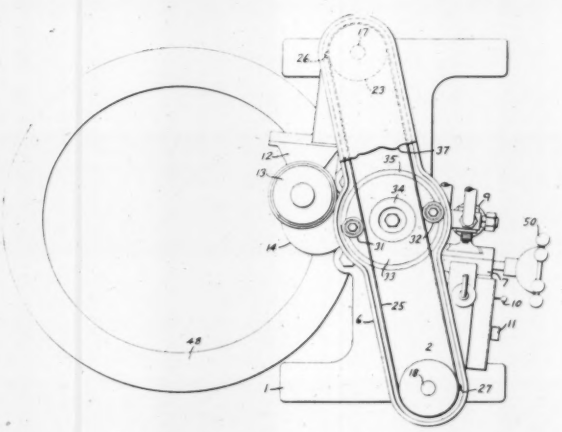


Fig. 2—Endless belt connects torch cutting head with tracer head. Belt is pinned on pulleys

TO CAUSE a pair of clutch elements or gears to approach the same speed just prior to being moved into mesh or driving relation a synchronizing device has been designed which embodies some of the features of clutches used in synchro-mesh transmissions. Howard J. Murray recently was granted a patent on it, which has been assigned to the R. M. Co. Inc., East Pittsburgh. In Fig. 3 is shown his unit embody-

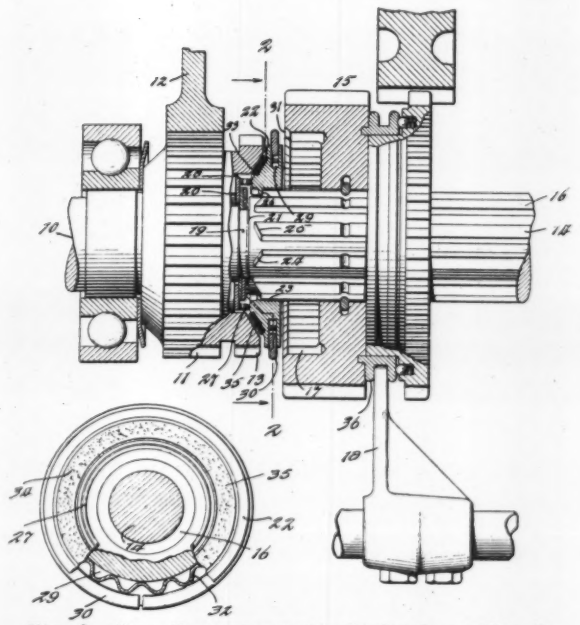


Fig. 3—Smooth engagement of clutch gearing is assured by employment of friction rings

ing a cone type synchronizer. As the gear 15 is shifted to the left the beveled ends 31 of the teeth of the internal gear 17 will be brought into engagement with the split ring 30. The ring will function as a resilient stop and transmit the movement of the shiftable unit directly to the shiftable clutch ring 22, causing it to be forced into clutching engagement with the conical end of the main gear.

The shiftable unit tends to hold the synchronizer ring 22 to its own speed which obviously would be different from the speed of the main drive gear. Cam faces are caused to bear on the inclined faces of synchronizer ring 22 and thus tend to force the ring further into frictional engagement with the main gear. In this way there is effected a direct frictional drive between shafts 10 and 14

As unit 15 continues to move to the left it will act on split ring 30 and contract it out of the path of movement of the shifting gear unit and in this way permit the internal gear to telescope the synchronizing device and to move into direct clutching engagement with the male element. The split ring 30 in its tendency to expand while telescoped by unit 15 will bear on the teeth of female clutch member 17 and thus assist in holding the jaws in their interclutching position. The patent is designated No. 1,853,988.

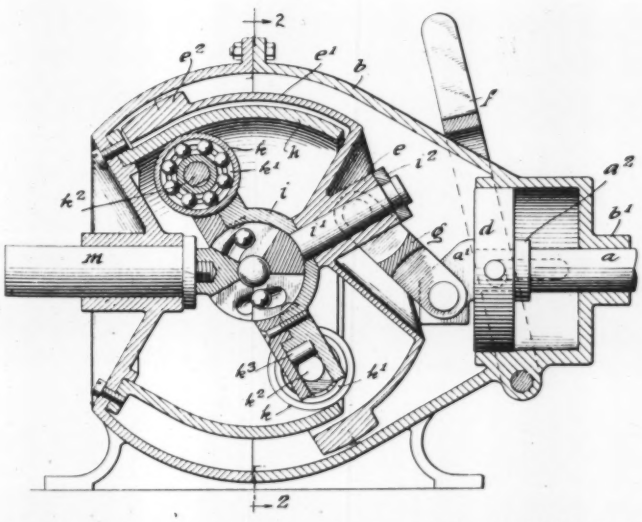


Fig. 4—Balancing body is provided to eliminate vibration in a universal joint type of variable speed transmission

VIBRATION in a variable speed power transmitting device designed by Carl W. Weiss, New York, is eliminated by a method of balancing covered by patent No. 1,881,154. Construction of the device incorporating means whereby this is accomplished, is shown in Figs. 4 and 5. When driving shaft a is moved to the left as indicated in the drawing, mutor i is caused to nutate about the common center and to effect, through the universal joint, rotation of the driven shaft m. Speed of this shaft is governed by the angle of stub shaft i with the axis of a.

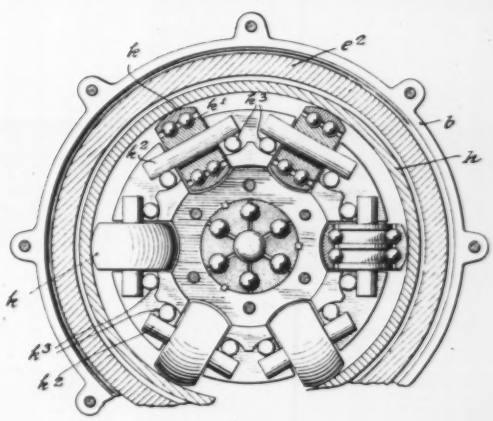
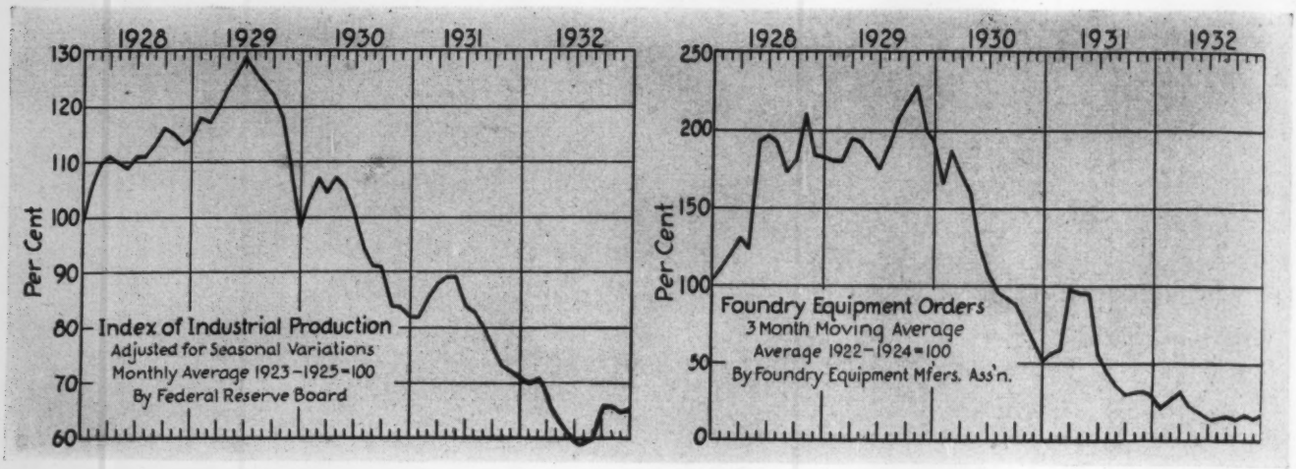


Fig. 5—Nutating element is supported by ball-mounted gripping elements in the spherical member

When moving shaft i^1 the balancing body e^2 is moved to a corresponding angular position while continuing to rotate about the axis of the device. Under these conditions the centrifugal force developed in the balancing body tends to move it toward its initial position in a plane at 90 degrees to the axis of rotation and so creates a couple with the moment of magnitude equal to and in a direction opposite to the moment of inertia of the nutating member or mutor.

Rotation of the mutor on its axis which is the axis of stud shaft i^1, when such axis is at an angle to the axis of the driving shaft, sets up a gyroscopic force in a direction opposite to the force of inertia of movement of mutor nutation and indicates a reduction of weight of the balancing body. It will be seen that as the magnitude of the forces, centrifugal, inertia and gyroscopic involved in the operation of this device is a function of the angle of nutation, balance of the structure at all angles of nutation is assured.

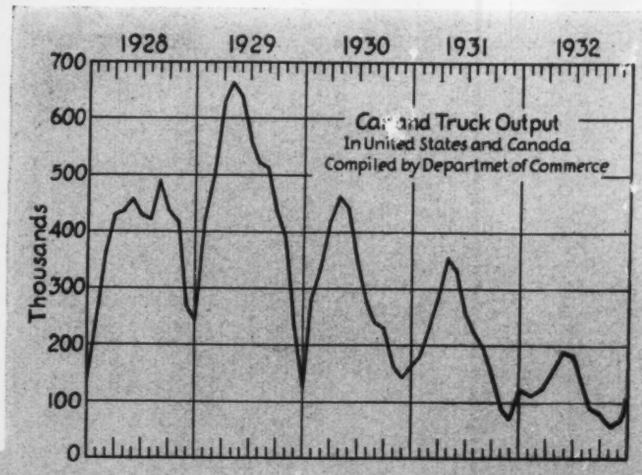


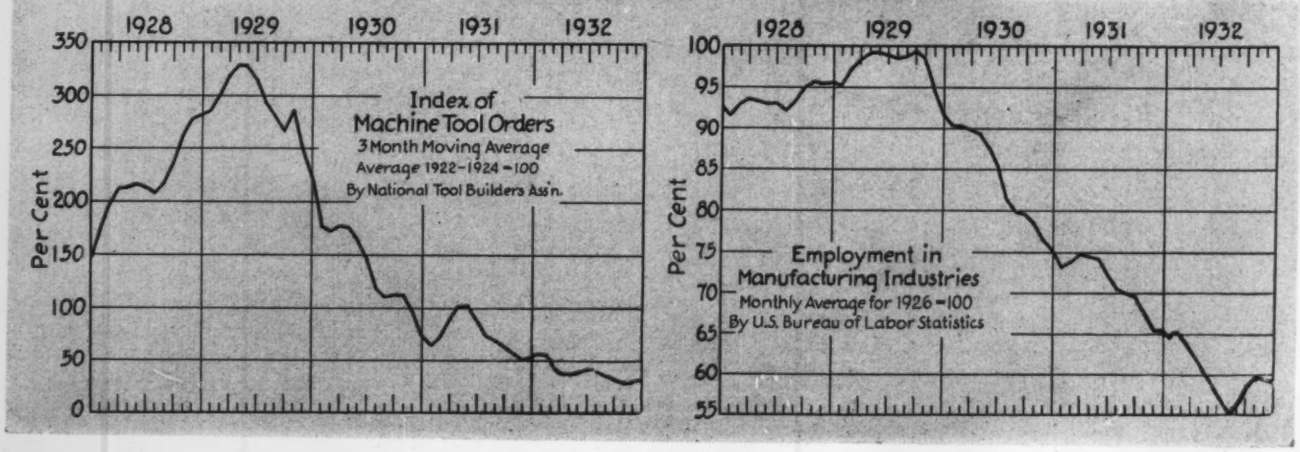
How Is Business?

MACHINERY and tool manufacturers, long in the business doldrums, may be the first to recover if the record of commercial failures for 1932 is taken as a criterion. Failures in this group dropped 40 per cent from the 1931 total of liabilities while number of failures, although larger than 1931, is still 19 per cent under the all-time failure record established by these organizations in 1921.

These figures are especially encouraging when considered in relation to the staggering totals registered in industry as a whole. The only other groups to show improvement were the manufacturers of woolens, carpets and knit goods and of tobacco and tobacco products. In the late months of 1932 the total of commercial failures reversed a 3-year trend by falling under the similar number for the same month the previous year. In the first two weeks of 1933 there has been a further drop and failures are 13 per cent under the total for the same period last year.

Important barometers of general business indicate that business is on the uptrend and soon may equal or surpass the points reached last October. Such an indication is especially valuable when it is recalled that steel ingot operating rate, electric power output and car loadings exert considerable influence on the totals. Freight volume and power output are expanding moderately and the steel rate has mounted steadily. Production of the recently introduced automobile models is a potent factor in these increases.



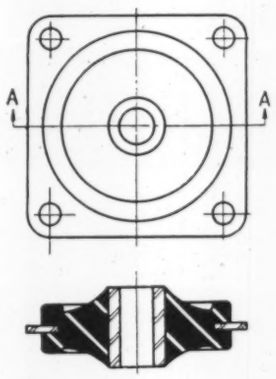


NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Shear Type Mountings Developed

SHEAR type mountings of rubber bonded to steel are being manufactured by Lord Mfg. Co., Erie, Pa. Plate form mounting, designed for small machine and instrument installations, have a washer-like metal plate and a central metal tube connected by rubber bonded to the tube and plate. In use, the rubber is disposed to sustain the major vibratory thrusts yieldably in shear. The mountings, shown herewith, have a load rating based on 1/16-inch deflection under load. This rating is referred to only as indicating an approximation of what may be



Mountings designed for use with shear loads are disposed to sustain major vibratory thrusts yieldably in shear

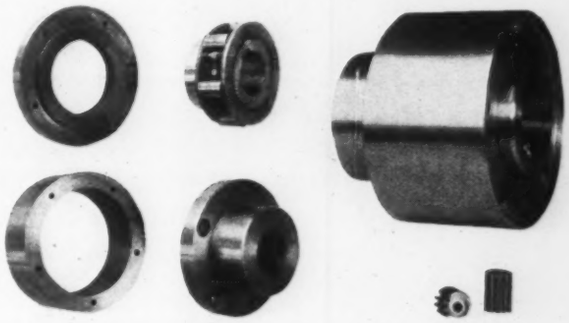
used. Deflections should be varied to suit different vibratory conditions.

Other mountings offered by the company include the tube form, double mountings and many special types. The company manufactures a complete line of bonded rubber products.

Announces Free Wheeling Clutch

FREE wheeling clutch-couplings suitable for industrial applications, formerly known as the Columbia One-Way clutch, now are being marketed by Kelpo Clutch Co., 216 Mill street, Rockford, Ill. When the cam gear in the clutch, upper center in the illustration, is rotated in the driving direction by the drive shaft to which it is coupled, it turns cams, lower right, so that they grip the case, lower left, and drive the load through the cover, upper left, and the flange, lower center.

When the load shaft rotates faster than the prime mover shaft, or free wheels, the cams allow the case to slip past them freely. Springs serve to keep the cams in contact with the ring

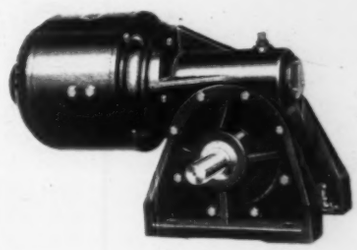


Free wheeling clutch coupling may be assembled to operate with drive shaft rotating in either direction

ready to grip. The cover is a press fit on the ring and is fitted with a felt grease seal where the drive gear passes through it. Clutches may be assembled to operate in either direction.

Motorized Reducers Are Compact

TWO new types of motorized speed reducers have been made available by Janette Mfg. Co., Chicago. With these types RW-3 and RW-4



Ball bearing motor is bolted directly to the gear housing in new line of motorized reducer units

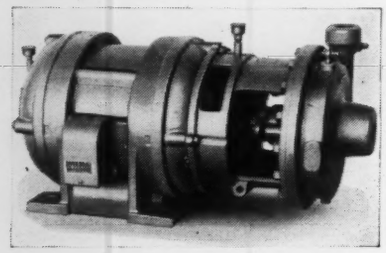
it is possible to obtain motor horsepower of from 1/3 to 5 horsepower in polyphase or direct current, and motor speed of 1140, 860, 690 and 575 revolutions per minute. Twelve standard ratios

ranging from 90:1 to 8:1 are available.

The drives, shown herewith, are worm gear reduction units consisting of a ball bearing motor bolted directly to the gear housing. The worm is mounted on the extended motor shaft, the outer end of which is supported by a third ball bearing. Two tapered roller bearings support the slow speed shaft. These units are so designed that they may be obtained in eight different mounting positions.

New Pumping Units Introduced

THREE sizes, designed to work against heads up to 100 pounds and above and covering a range in capacity from 30 to 140 gallons per minute have been added to the line of SSU motor-driven pumping units built by Allis-Chalmers Mfg. Co., Milwaukee. A single shaft is used on which to mount the motor rotor and the pump impeller of the unit, shown herewith. The shaft is supported by two ball bearings, a construction that eliminates possibility of misalignment between the pump and the motor.



Single shaft is used on which to mount motor and pump impeller

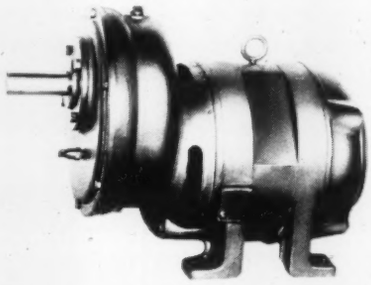
Lubricator Provides Automatic Feed

AUTOMATIC, visible lubricating systems for ring or ball bearing shafts, known as the Opto-Matic Oiler have been placed on the market by Trico Fuse Mfg. Co., Milwaukee. The oiler, shown herewith, is designed to provide an automatic continuous oil feed. Micrometer adjustment permits a wide range of oil levels obtainable by turning the glass oil reservoir. The reservoir may be filled annually or semi-annually as required. Adequate protection is provided for the reservoir in the form of a wire guard, furnished as an accessory.

An automatic continuous feed of oil is provided by visible lubricating system which usually is replenished only annually or semiannually

Combines Reducer and Motor

SPEED reducers and motors combined in single units as manufactured by D. O. James Mfg. Co., Chicago, are available from ½ to 20 horsepower with a wide range of ratios and speed. Gears are of continuous tooth herringbone construction, are mounted on antifriction bearings, and run in a bath of oil, making a compact, efficient and space saving drive.

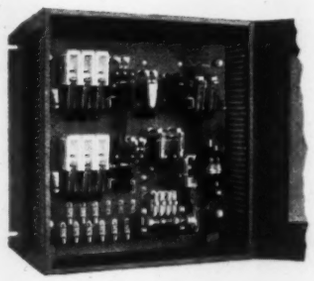


Gears in combined speed reducer and motor are of continuous tooth herringbone construction

Controls Are Self-Timing Type

ALTERNATING current controllers designed to meet the requirements of laundry machinery have been placed on the market by Monitor Controller Co., Baltimore. This controller, shown herewith, is of the self-timing type, employing a motor driven cam timing device which governs the automatic reversal of the machine cylinder and also determines the proper drift period between reversals. This drift period is made adjustable so that the actual drift period requirements of the machine may be met.

Contact fingers which control the reversing contactors have silver-to-silver contacts. The device is driven by a small pilot motor through



Motor driven cam timing device governs automatic reversal of the machine cylinder

Sales Appeal for 1933

● To design motor-driven machinery today without attention to the operating economies provided by carefully selected Motor Control is to lose a particularly timely sales feature. Economy is now the watchword in factory operation and thus a focal point in the purchase of factory equipment.

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●

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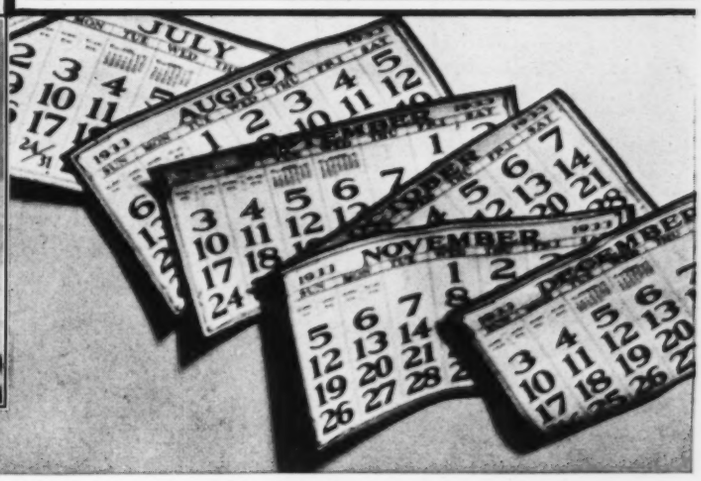

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Tubes measured 1.032" inside diameter and were 15 feet long. The bend had a 5" radius. Desired speed of wire brush was established at 1750 r.p.m. As tubes were generally wet and at high temperature when they were cleaned, the transmission element had to be unaffected by these conditions.

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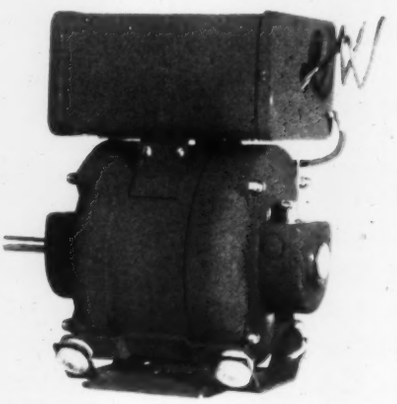
suitable gearing. Standard gear ratio provides approximately four reversals per minute of the machine, and two spare gears are provided which permit this to be changed to 3, 5 or 6 per minute. The drift period adjustment is sufficient for this range of reversals.

Capacitor Motors Operate Quietly

IMPROVED capacitor type motors especially designed for refrigerator service are a recent development of Ohio Electric Mfg. Co., Cleveland. This motor, shown herewith, does not use a wound rotor, commutator and brush and brush lifting system. The unit has a combination rubber cushion, spring mounting, recirculating lubrication and burnished bearings. Construction is simple and operation quiet.

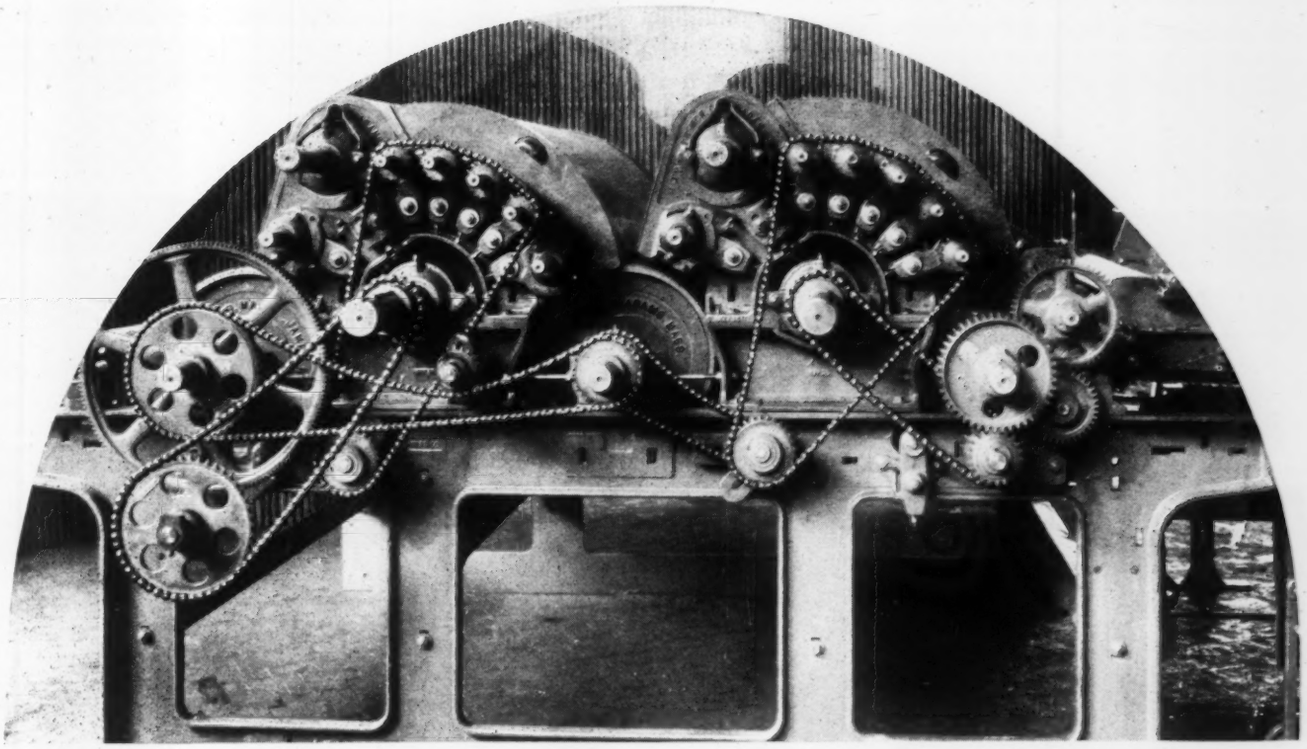


Especially designed for quiet operation, capacitor motors have combination rubber and spring mountings

Produces Flexible Reduction Units

THE new line of double reduction worm gears produced by De Laval Steam Turbine Co., Trenton, N. J., has the high speed gear wheel mounted upon the slow speed worm shaft. Flexibility in the arrangement of the drive has been gained by using separate housings for the high speed gear and the slow speed gear. For example, the unit with vertical slow speed shaft can be combined in six ways, namely: with the high speed shaft at the right and with the vertical driven shaft extending either upward or downward, or in both directions, and similarly with the high speed shaft at the left. The unit with horizontal slow speed shaft, can have the high speed driving shaft extended in either or both directions, and likewise the slow speed shaft. The worm may be rotated either clockwise or counter-clockwise, facing the worm from the motor or driving position. Standard gear sets are cut with right hand threads.

All gear tooth and worm surfaces and the



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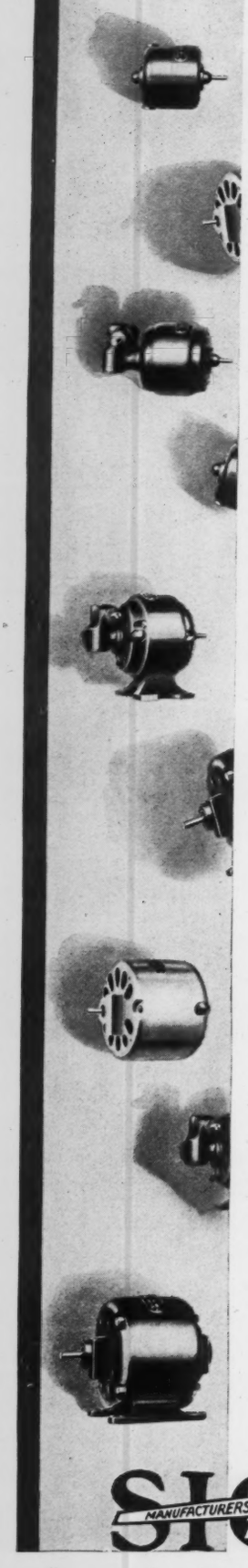

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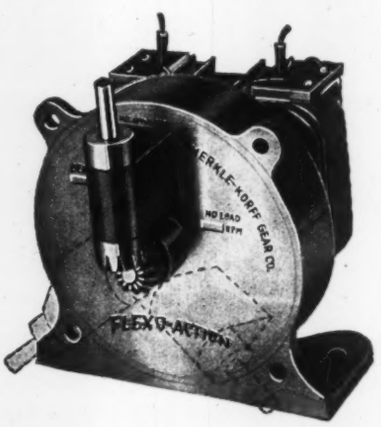
bearings are lubricated by a splash system, the high speed gear wheel and the slow speed worm dipping in an oil bath in the casing. High speed worm shaft and the shaft which carries the high

High speed gear wheel rotates on slow speed worm shaft in new line of double reduction worm gears

speed gear wheel and the slow speed worm have ball bearings. The slow speed shaft, which in double reduction gears may be called upon to carry considerable forces, has plain sleeve bearings, or, in units in which the slow speed shaft is horizontal, may be fitted with tapered roller bearings.

Motor Reduction Units Are Reversible

INTEGRAL motor drive for low torque requirements is provided by the new power reduction units brought out by Merkle-Korff Gear Co.,

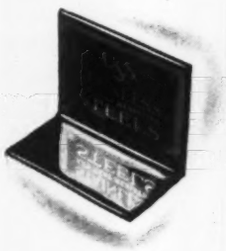


Drive for low torque requirements has a reduction unit assembled with a two-pole motor

213 North Morgan street, Chicago. The unit, shown herewith, consists of an assembly of a reduction unit with a two pole reversible motor. It is designed to start, stop and run in either direction under the control of a simple switching means.

Special units can be furnished for any voltage from 12 to 230 and for any frequency from 25 to 60 cycles. 115 volts, 60 cycles is considered as standard. The units operate at a full load

Eliminating the Guesswork from Stainless Steel Specifications



USS 25-12
for resistance to high temperatures

USS 25-12 is highly resistant to a wide variety of corrosive agents, and especially to an appreciable amount of sulphur in surrounding gases.

It is austenitic and hence not intended for those applications requiring hardening by heat treatment. Its ductility is such as to provide for a considerable amount of drawing and forming.

USS 25-12 is the ideal steel for most high temperature services. It does not oxidize rapidly below 2100 degrees F., and in addition, retains a large proportion of its strength and toughness throughout its range of application.

Other USS Stainless and Heat Resisting Steels are:

Chromium Alloy Steels		Chromium Nickel Steels
Ferritic		*Austenitic*
USS 12 & 12Z		*USS 18-8*
USS 17		*USS 18-12*
USS 27		*USS 25-12*

Illinois Steel Company
CHICAGO, ILLINOIS

CARNEGIE STEEL COMPANY
PITTSBURGH, PA.

SUBSIDIARIES OF
UNITED STATES STEEL CORPORATION

In this day when public demand for stainless steel has become so insistent, manufacturers are faced with the task of selecting from the many types of Stainless Steel, the one most ideally suited to specific needs.

Such selection involves consideration of the variation in corrosion-resistant characteristics of the various types as well as careful analysis of the physical characteristics as to strength and workability.

Our metallurgists will be glad to work with you in the necessary studies and in specifying the ideal Stainless Steel for your needs.

USS STAINLESS AND HEAT RESISTING STEELS

U S S CHROMIUM-NICKEL ALLOY STEELS ARE PRODUCED UNDER LICENSES OF THE CHEMICAL FOUNDATION, INC., NEW YORK, AND FRIED. KRUPP A. G. OF GERMANY

Fastening Question and Answer No. 2

Is there a time-saving Way to make strong fastenings *in hard-to-get-at places . . ?*

HERE'S a problem that bothers a good many production departments. To use rivets or bolts and nuts in cramped places causes a great deal of fumbling, poor fastenings, etc. When machine screws are used costly tapping is required and frequently there is difficulty in starting screws.

Most manufacturers, today, are using time and labor-saving Hardened Self-tapping Sheet Metal Screws. In making hard-to-get-at fastenings, these Screws have no equal. You just turn them into holes, drilled or punched in the metal . . . making the fastening as simply and easily as you make a fastening with wood screws. And, besides saving money, these unique Screws actually make stronger fastenings than machine screws or nuts and bolts.

You should try these Screws for all of your assembly jobs that require fastenings to sheet metal, steel, aluminum, die castings, Bakelite, slate, ebony asbestos, etc. Last year 840 manufacturers tried Self-tapping Screws and found them money-savers. It will pay you to use the coupon below.

PARKER-KALON

HARDENED TYPE Z SELF-TAPPING

Sheet Metal Screws

PATENTED—No. 1809758, No. 1827615

Parker-Kalcn Corp., 202 Varick St., New York

Send trial samples with recommendations for making fastenings briefly described on attached sheet.

Name and title .....

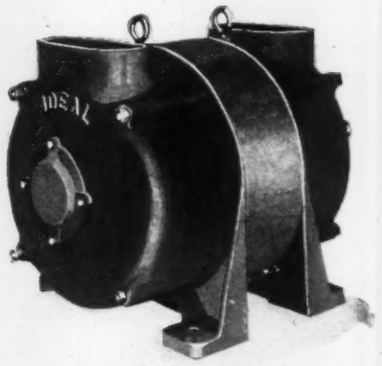
Company .....

Address .....

speed of 1500 revolutions per minute and no load speed of 2600. They can be furnished with either horizontal or right angle drives and have an input of 38 amperes and 20 watts.

Motors Are Efficiently Ventilated

ESPECIALLY designed for applications where the advantages of a totally enclosed motor are desired, the pipe ventilated motor introduced by Ideal Electric & Manufacturing Co., Mansfield, O., has ventilation supplied by a centrifugal fan which draws clean air in at one end and discharges warm air from the other. The unit, shown herewith, is a totally enclosed, polyphase, squirrel cage induction motor. Intake opening may lead to any source of clean cool air while outlet may be left free to discharge into the room or may be piped outside. Vent pipes are connected to the vent stacks shown.



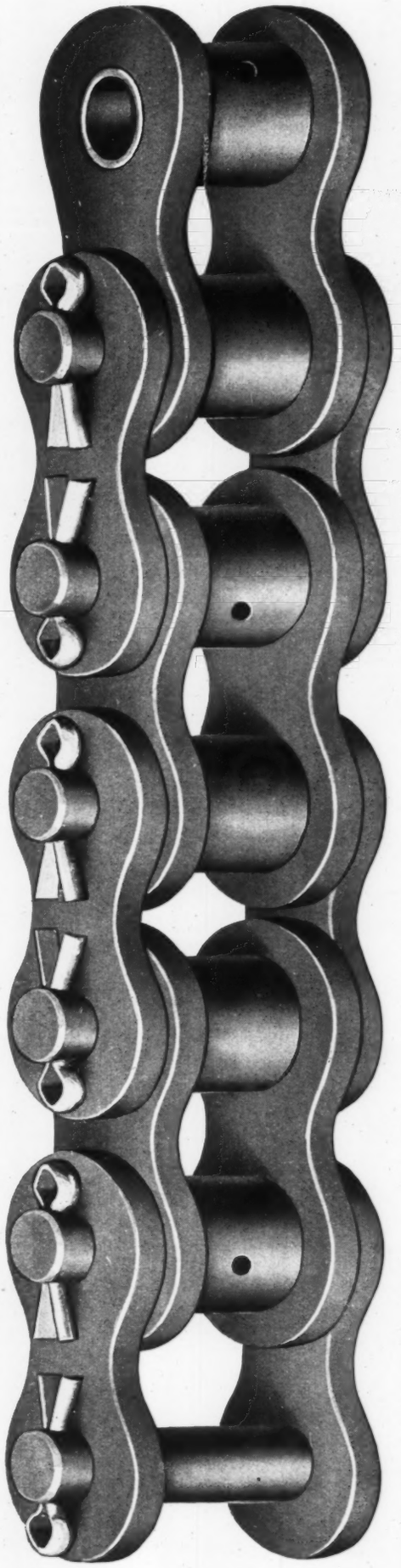
Totally enclosed, polyphase, squirrel cage motor is ventilated through pipes leading to cool air

The motors are supplied to meet all torque and inrush classifications for both squirrel cage and slip ring induction motors from 1 to 200 horsepower, including across-the-line start motors. Unity and leading power factor induction motors also can be furnished.

Whipcord Is Used as Cone Belt Base

WITH the strength member consisting of a layer of closely spaced pretreated whipcord, wound continuously and completely embedded in rubber, the cone belts redesigned by Manhattan Rubber division of Raybestos-Manhattan Inc., Passiac, N. J., are said to have an increased service life of four to eight times that of earlier designs. Low inelastic stretch, high degree of bending flexibility and ample tensile strength are features of the new belt.

In addition to the new design, the company has combined the various odd sizes of cone belts into sixteen standard sizes which provide a belt that will fit correctly all cone drives without change in the pulley set-up.



STRENGTH ...and... POWER

EVERYTHING these words imply and reflect is represented in the design and manufacture of Baldwin-Duckworth Alloy Steel Roller Chains.

The facilities of our entire Engineering Division are available to manufacturers in diversified industries to help them first calculate and second design the drive best suited for individual requirements.

We welcome the opportunity of demonstrating and proving why this essential engineering function has gained for our organization and established for our product the term which we are proud to emphasize—

DEPENDABLE.. ...DRIVES

BALDWIN-DUCKWORTH Alloy Steel Roller Chains are precision-made so as to deliver a margin of performance beyond maximum requirements. Meeting the necessity for power transmission in strength is one thing. Exceeding the maximum requirements which incorporate a margin of safety and insurance is quite another thing.

BALDWIN-DUCKWORTH • CHAIN CORP. •
SPRINGFIELD, MASSACHUSETTS

FACTORIES AT SPRINGFIELD AND WORCESTER ∴ MASSACHUSETTS

Constructing Nomograms for Use in Design

(*Concluded from Page 35*)

the actual calculation of each point. Such scales may be taken quite readily from ordinary cross section or logarithmic paper. The three scales of Fig. 3 all were taken from the same sheet of logarithmic paper.

As stated in the first part of this article, an alignment diagram for an equation of more than three variables consists of several simple diagrams of three variables each. An example will best illustrate this principle as well as the method of construction of such diagrams. Assume that it is desired to plot a diagram for the equation $I.H.P. = PLAN/396{,}000$ where $I.H.P.$ is indicated horsepower developed; P is mean effective pressure in pounds per square inch; L is length of stroke in inches; A is the piston area in square inches; and N is the number of power strokes per minute. Again it will be necessary to take logarithms, which reduces the equation to:

$$\log (I.H.P.) = \log P + \log L + \log A + \log (N/396{,}000)$$

This equation may be separated into equations of three variables in the following manner: let

$$F_1 = \log A + \log (N/396{,}000) \quad \ldots\ldots (9)$$
$$F_2 = \log L + F_1 \quad \ldots\ldots (10)$$
$$\log (I.H.P.) = \log P + F_2 \quad \ldots\ldots (11)$$

After calculating the necessary scale factors from the desired range of variables and proper spacing of the scales, an alignment diagram for equation (9) may be plotted as illustrated previously. The three axes of this diagram are A, B and C in Fig. 4. Inasmuch as only a point on the scale and not the actual value of F_1 has any significance, the function scales for A and N are plotted but only the axis for F_1 drawn. This type of scale, which always occurs in the case of equations of more than three variables, is called a pivot. The diagram for equation (10) now may be plotted, using the same axis and same scale factor for F_1. The scale factor for F_1 along with the calculated scale factor for the function scale for L will determine the scale factor for F_2. The axes for this diagram are A', B' and C'. Then, using the same axis and scale factor for F_2 and calculating the other necessary scale factors, the diagram for equation (11) may be drawn. These axes are A'', B'' and C''. The dotted lines on the diagram represent both the method of solution and the method of locating (along its axis) the scale for $I.H.P.$

21 out of 23
PASTEURIZERS
at the DAIRY EXPOSITION
were powered with
MASTER
★ THE ORIGINAL
GEARED-HEAD
MOTORS
BEFORE
AFTER
Send
your blue prints to us for
MASTER RE-DESIGN
Even if you believe your design impossible of further refinement, see what MASTER says. There will be no obligation of any kind for the unbiased opinion and ideas we will submit to you.
Our accumulated experience in improving power-drives for more than 1000 leading manufacturers is at your disposal, without cost---and with probable saving---if you will WRITE NOW!
Address
DIVISION U
A breadth of experience only possible from application to almost every conceivable type of motor-driven machine brings to this combined motor and integral speed reducer an aging that, literally, has removed all the 'bugs'.
Performance and sales appeal as new as to-morrow urge that you take advantage of this ...
"MORE THAN A MOTOR--THE WHOLE POWER DRIVE"
THE MASTER ELECTRIC COMPANY
DAYTON OHIO U.S.A.

Frankie AND JOHNNIE

(DESIGNER'S VERSION)

Frankie is the equipment you design (in this version) — Johnny is the villain in the song, alias Faulty Lubrication.

And ever and always, no matter how good a bit of equipment *she* is, *he* does her wrong.

It is, of course, absolutely necessary to design *into* equipment the proper, protective Alemite Lubrication System. Grease Cup and Oil Hole "lubrication" methods are obsolete and inefficient.

But to trust a modern Alemite High Pressure Lubrication System with "random" greases is like Frankie trusting Johnny with another blonde. Dangerous curves ahead!

From your standpoint as a designer, those curves are on a chart and they swing upwards — mounting maintenance costs through unnecessary breakdowns and repair bills.

To be SAFE, to be SURE that your equipment will operate with maximum efficiency, recommend that Alemite Industrial Lubricants be employed in Alemite High Pressure Lubrication Systems. Then NOBODY will do ANYTHING wrong!

ALEMITE CORPORATION (Division of Stewart-Warner), 2644 N. Crawford Avenue, Chicago, Illinois 695

Gentlemen: I am interested in information regarding Alemite Systems and Lubricants from the designer's standpoint.

Name..... Company.....

Address..... City..... State.....

PIONEERS IN SPECIALIZED LUBRICATION FOR INDUSTRY

ALLEN

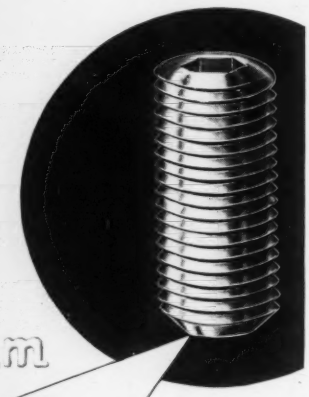
TRI-MARKT
TRADE MARK

HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um



Help you show savings in shop maintenance and operating costs —the BIG end to save on

DOLLAR savings in the shop or penny savings at the Purchasing Agent's desk:—WHICH do you want today? Your answer to that will decide the question of which HOLLOW SCREWS do you want. . . For 22 years there have been but two kinds—Allens and others —offering savings on opposite ends. The *maintenance* and *operating* end gets the breaks when you specify ALLENS. May we send you test samples?

THE ALLEN MFG. COMPANY
HARTFORD, CONN. U. S. A.

BUSINESS AND SALES BRIEFS

George Tinsley has become associated with the sales department of Ackerman Mfg. Co., Warwood, W. Va., a subsidiary of the Wheeling Corrugated Co. The Ackerman company manufactures and distributes stampings.

* * *

John W. MacMorris has been engaged as factory manager for Norma-Hoffmann Bearings Corp., Stamford, Conn. This connection has been announced by the company as a step in the preparation for larger production.

* * *

Riverside Metal Co., Riverside, N. J., has begun the manufacture of beryllium copper alloys. It is producing beryllium copper in the form of rods, sheets, wire and strip.

* * *

Robert E. Kinkead Inc., consulting engineers on welding, has removed to 3441 Lee road, Shaker Heights, O.

* * *

H. T. Gilbert has been appointed as Chicago district sales manager for Illinois Steel Co.

* * *

Nelson E. Chance, formerly district manager of the Houston office of Brown Instrument Co., Philadelphia, has been appointed assistant sales manager with headquarters at Philadelphia.

* * *

Foote Bros. Gear & Machine Co., Chicago, has announced the appointment of William E. Peck to succeed Ralph Wirth in the State of Indiana with the exception of Lake, Porter and La Porte counties and the Ohio river towns.

* * *

Earl L. Ramsey, who has been in the general sales office of Ex-Cell-O Aircraft & Tool Corp., Detroit, is now production engineer working with sales representatives in the different territories covering all products of the company.

* * *

Howard A. Holmes, recently assistant district sales manager at Chicago for the Weirton Steel Co. and prior to that in the Detroit office of the company, is now identified with the Detroit sales office of the Inland Steel Co. J. H. Fitch is Inland sales manager at Detroit.

* * *

O. B. Wilson, formerly manager of the Cleveland office of Brown Instrument Co., has been appointed district manager for the company in the territory comprising Texas, Louisiana and Southern Arkansas. His headquarters will be in Houston, Texas.

* * *

C. B. Templeton, formerly assistant to the president of the Ludlum Steel Co., Watervliet, N. Y., is now assistant to the vice president in charge of sales. Nevastian and nitraloy steels, formerly handled by the Associated Alloy Steel Co., Cleveland, will be included in the company's complete line.

* * *

Sales agents recently announced by Advance Pressure Castings Inc., 34 North Fifteenth street, Brooklyn, N. Y. are: F. X. Morris, 448 Irvington Road, Drexel Park, Pa.; L. E. & L. Sales Engineers, 212 Humber building, Highland Park, Mich.; W. R. McDonough Co., National building, Cleveland; B. J. Steelman, 224 South Michigan avenue, Chicago; and A. G. Werner, 5522 South Thirty seventh street, St. Louis.

79% of the contract advertisers in Machine Design in 1929 have renewed for 1933. The remaining 21% are doing no publication advertising at the present time.